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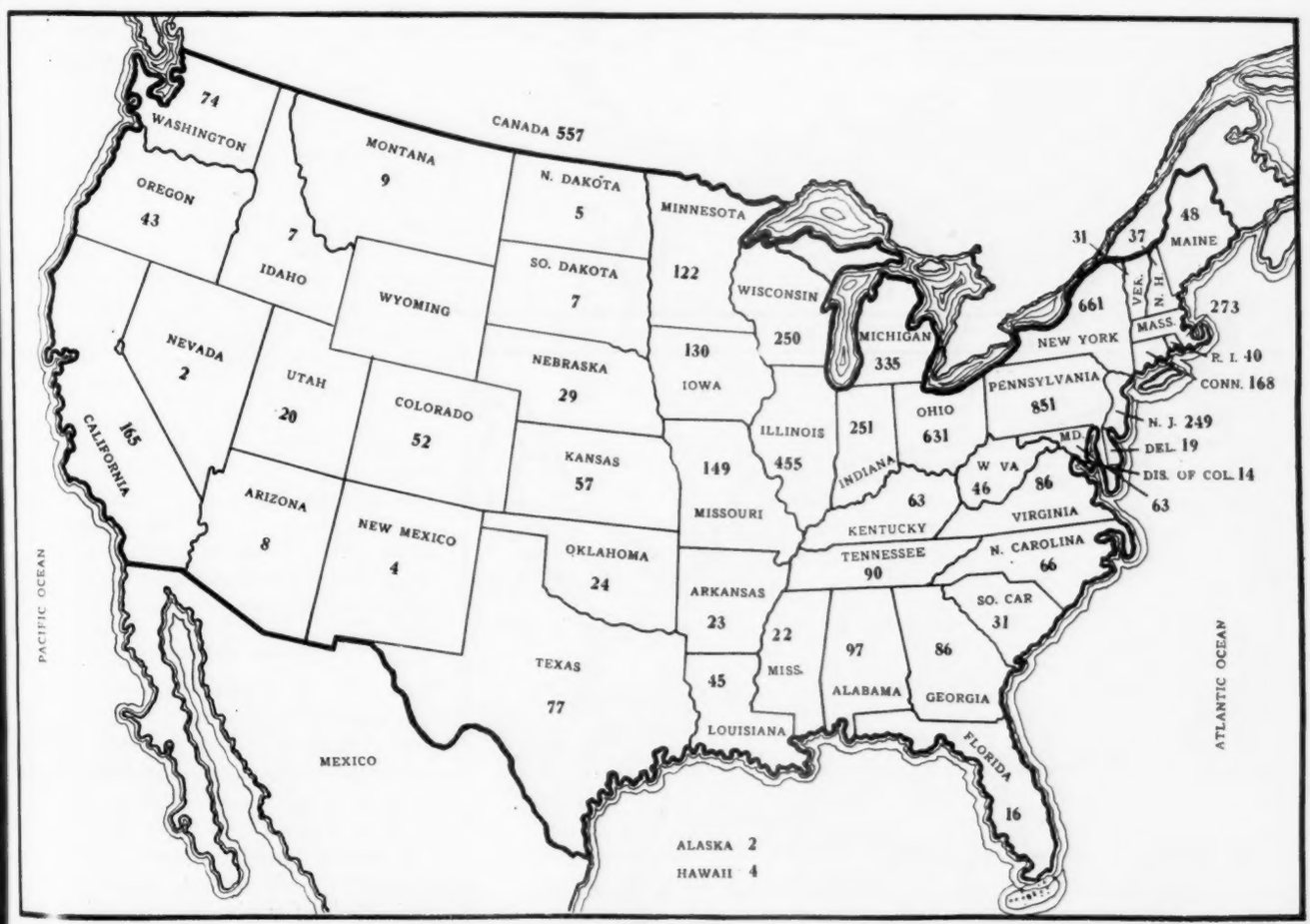
THE FOUNDRY

Vol. 36, No. 3 | Cleveland, Ohio, May, 1910 | Whole No. 213

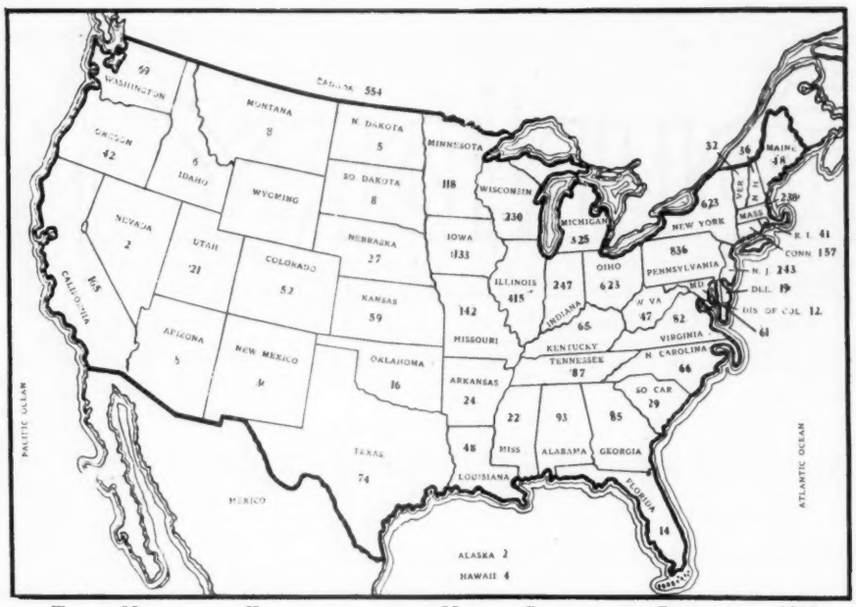
THE FOUNDRY INDUSTRY IN 1910

Total number of foundries in the United States and Canada --- Statistics of the iron, steel, malleable and brass foundry trades

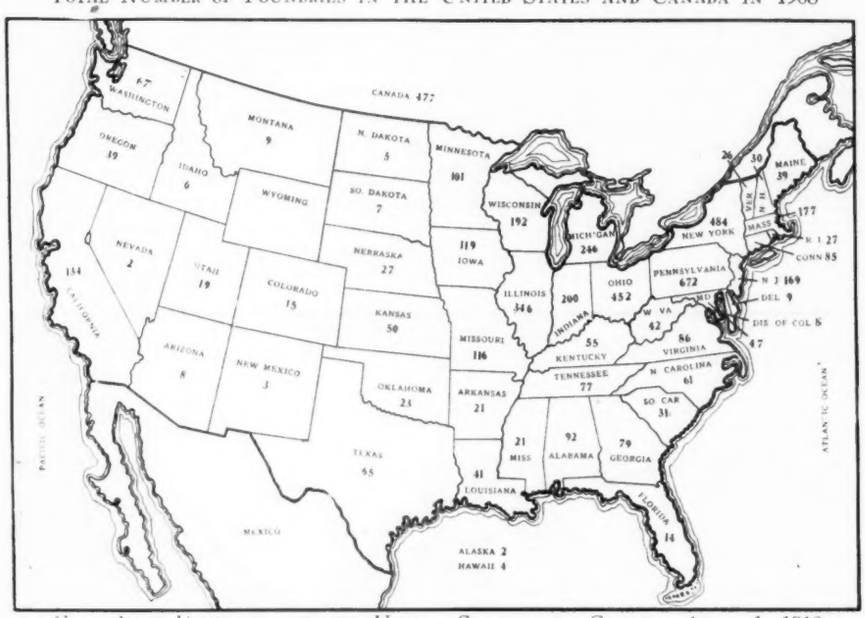
THE foundry industry of the United States and Canada has shown a marked growth during the past two years, notwithstanding the business depression, which resulted in the embarrasment of many concerns and the dismantling of many plants. Statistics compiled by THE FOUNDRY show a total of 6,594 foundries in the United States and Canada on April 1, 1910, against 6,366 in 1908, a net increase of 228. In 1906 there was a total of 6,108 casting plants, and the increase in the number of foundries in four years is 486. In compiling these figures, each plant was considered as a unit, regardless of the number of departments which it might contain. Practically all of the malleable shops melt gray iron for casting annealing boxes, and all converter steel plants operate gray iron departments, as the metal is first melted in cupolas before it is charged into the converters. The number of brass departments operated in conjunction with gray iron,



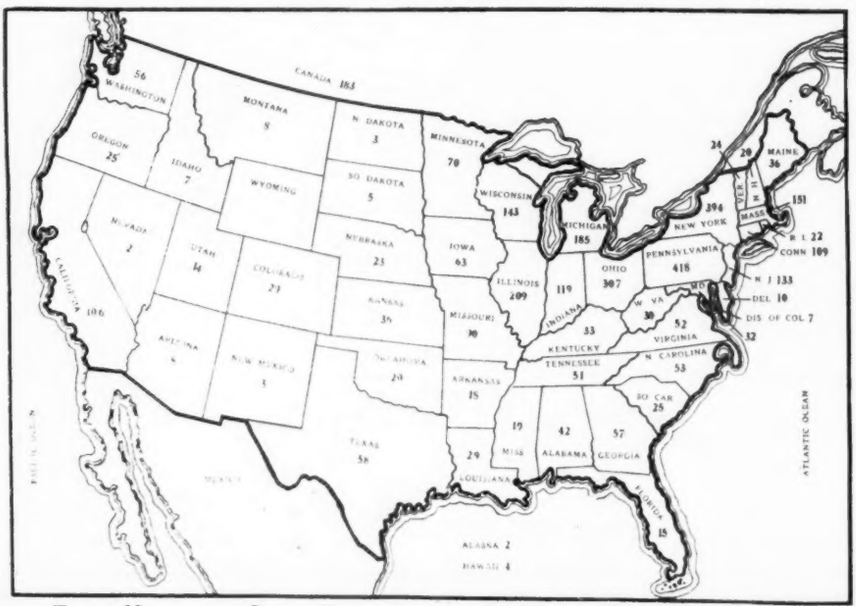
TOTAL NUMBER OF FOUNDRIES IN THE UNITED STATES AND CANADA, APRIL 1, 1910



TOTAL NUMBER OF FOUNDRIES IN THE UNITED STATES AND CANADA IN 1908



GRAY IRON FOUNDRIES IN THE UNITED STATES AND CANADA, APRIL 1, 1910



TOTAL NUMBER OF BRASS FOUNDRIES IN THE UNITED STATES AND CANADA, APRIL 1, 1910

steel and malleable foundries far exceeds the total number of brass foundries. Considering each foundry department as a unit, there are, therefore, 9,158 foundries in the United States and Canada.

In 1908, owing to the financial stringency, development was retarded, but during 1909 many new plants were erected. Improved trade conditions, with the increased demand for castings, have resulted in the erection of many new shops and together with the extensions to existing plants, will largely add to the foundry capacity. This development is widespread and is not limited to any particular section of the United States and Canada, thereby reflecting the general growth of the manufacturing industries of these two countries.

Increase.

Rebuilt plants and extensions are not shown by these statistics, and the net increase in the number of shops is considerably less than the total number of those that have been added during the last two years, owing to the large number that have been dismantled. There has undoubtedly been an enormous increase in the tonnage of iron and non-ferrous metals melted, but no figures have ever been compiled which accurately show the amount of raw material converted into castings.

Gray Iron Foundries.

The total number of foundries melting gray iron in 1910 is 5,157, against 5,105 in 1908, an increase of only 52. This is undoubtedly due to the dismantling of many small shops operated as departments of other manufacturing establishments. The low prices prevailing for all classes of castings, until the summer of 1909, permitted these concerns to purchase their material from other shops cheaper than they could produce the work themselves. In 1906 there was a total of 4,956 foundries melting gray iron, the net increase in four years amounting to 201.

Brass Foundries.

In compiling these statistics careful attention was given to securing accurate data regarding the shops melting non-ferrous metals exclusively including those casting brass, bronze, aluminum, etc. These have been termed "exclusive" brass foundries, of which there are 1,170 in the United States and 70 in Canada, a total of 1,240, against 1,096 in 1908, an increase of 144. Non-ferrous metal casting de-

partments of other foundries total 2,318 in the United States and Canada, and the total number of brass shops is 3,558. The growth of the brass foundry trade is largely due to the rapid development of the automobile industry, and in the Detroit district many new foundries have been built during the past two years to meet the requirements of this trade.

Foundries Melting Aluminum.

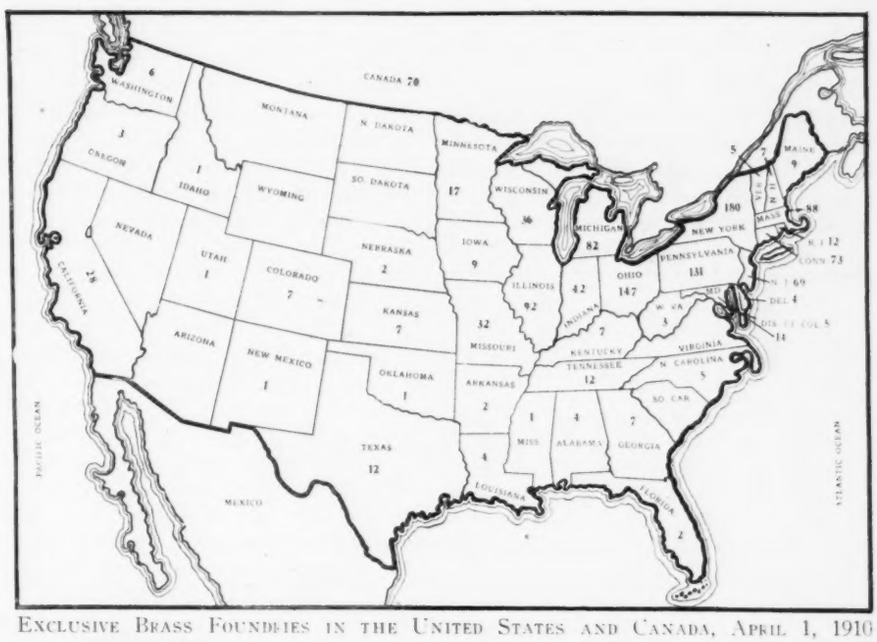
An effort has also been made to obtain accurate figures relative to the number of foundries melting aluminum, and no less than 1,679 concerns replied that they were engaged in the production of castings from this white metal. Nor is the production of aluminum castings limited entirely to brass foundries, as many gray iron shops have installed furnaces for this work. The melting of this metal involves no great difficulties, although considerable skill is required in the making of the molds and casting, owing to the excessive shrinkage of the metal.

Malleable Foundries.

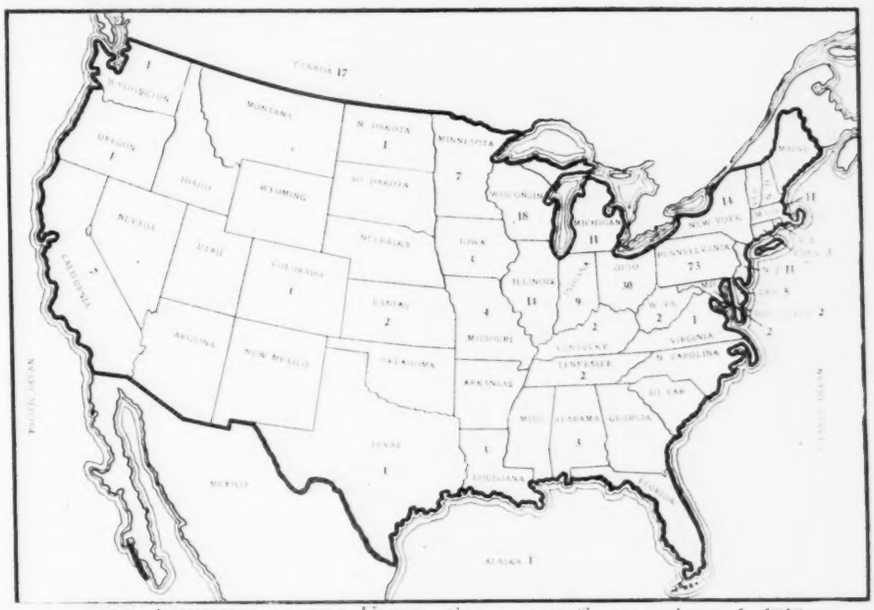
The malleable iron industry has shown a remarkable growth, the total number of plants having increased from 153 in 1908 to 178 in 1910. Canada has 10 malleable shops, 168 being credited to the United States. There has likewise been a big increase in the number of steel casting plants, the total for the United States and Canada now being 265, against 211 two years ago. This growth, in a measure, is due to converter installations by gray iron foundries, although a number of shops have added open-hearth furnaces. The number of plants producing steel castings by the crucible process has shown a slight increase, although the baby converter is making big inroads in the small steel casting trade.

Distribution of Foundries.

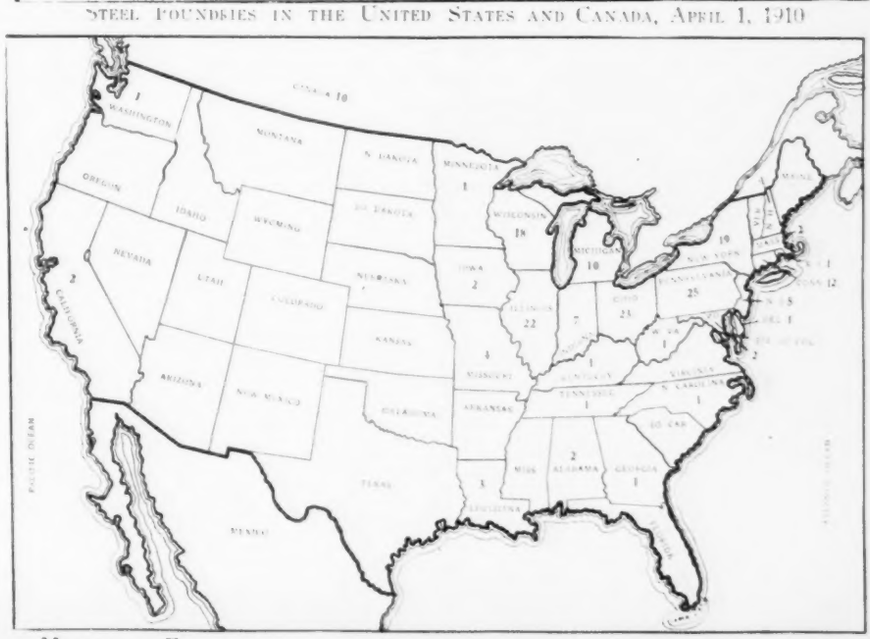
The accompanying charts graphically show the distribution of the casting plants throughout the United States and Canada, and the table gives the total number of foundries by states, whose relative positions of importance in the foundry industry remain practically unchanged. Pennsylvania leads by a wide margin, with 851 foundries, as compared with 83[illegible] two years ago. New York is second with 661, and Ohio third with [illegible], while in 1908 each of the latter two was credited with 623 shops. Illinois ranks fourth with 455, Michigan fifth with 335, and the other leading states



EXCLUSIVE BRASS FOUNDRIES IN THE UNITED STATES AND CANADA, APRIL 1, 1910



STEEL FOUNDRIES IN THE UNITED STATES AND CANADA, APRIL 1, 1910



MALLEABLE FOUNDRIES IN THE UNITED STATES AND CANADA, APRIL 1, 1910

follow in the order named: Massachusetts, 273; Indiana, 251; Wisconsin, 250; New Jersey, 249.

Pennsylvania again takes first rank in the number of gray iron foundries, being credited with 672, New York being second with 484, and Ohio third with 452. The other prominent states follow: Illinois, 346; Michigan, 246; Indiana, 200; Wisconsin, 192; Massachusetts, 177; New Jersey, 169; California, 134; Iowa, 119; Missouri, 116; Minnesota, 101.

In the total number of exclusive brass foundries New York leads with 180, Ohio is second with 147, and Pennsylvania third with 131. The other states follow: Illinois, 92; Massachusetts, 88; Michigan, 82; Connecticut, 73; New Jersey, 69.

In the total number of brass foundries, including the exclusive brass as well as the brass departments of other plants, Pennsylvania leads with

	Total foundries, 1910.	Total foundries, 1908.	Increase or decrease in two years.	Gray iron foundries, 1910.	Gray iron foundries, 1908.	Exclusive brass foundries, 1910.	Exclusive brass foundries, 1908.	Brass foundries, departments of other shops, 1910.	Total brass foundries, 1910.	Malleable iron foundries, 1910.	Steel foundries, 1910.	Foundries melting aluminum, 1910.
UNITED STATES—												
Alabama	97	93	4	92	86	4	6	38	42	2	3	13
Alaska	2	2	....	2	2	.....	.....	2	2	...	1	1
Arizona	8	8	....	8	8	.....	.....	8	8	...	...	2
Arkansas	23	24	—1	21	21	2	3	16	18	...	...	4
California	165	165	....	134	139	28	23	78	106	2	7	61
Colorado	52	52	....	45	44	7	8	22	29	...	1	12
Connecticut	168	157	11	85	88	73	62	36	109	12	3	56
Delaware	19	19	....	9	11	4	4	6	10	1	5	5
District of Columbia	14	12	2	8	9	5	2	2	7	...	2	3
Florida	16	14	2	14	14	2	.....	13	15	...	...	7
Georgia	86	85	1	79	80	7	5	50	57	1	...	27
Hawaii	4	4	....	4	4	.....	.....	4	4	...	...	2
Idaho	7	6	1	6	6	1	.....	6	7	...	...	2
Illinois	455	415	40	346	334	92	63	117	209	22	14	120
Indiana	251	247	4	200	203	42	38	77	119	7	9	53
Iowa	130	133	—3	119	125	9	7	54	63	2	3	34
Kansas	57	59	—2	50	54	7	5	29	36	...	2	26
Kentucky	63	65	—2	55	55	7	7	26	33	1	2	12
Louisiana	45	48	—3	41	43	4	5	25	29	3	3	3
Maine	48	48	....	39	38	9	10	27	36	...	...	14
Maryland	63	61	2	47	46	14	15	18	32	2	2	11
Massachusetts	273	238	35	177	163	88	87	63	151	2	11	87
Michigan	335	325	10	246	244	82	69	103	185	10	11	104
Minnesota	122	118	4	101	99	17	16	53	70	1	7	41
Mississippi	22	22	....	21	19	1	3	18	19	...	...	2
Missouri	149	142	7	116	122	32	29	58	90	4	4	41
Montana	9	8	1	9	8	.....	.....	8	8	...	...	1
Nebraska	29	27	2	27	25	2	2	21	23	...	...	15
Nevada	2	2	....	2	2	.....	.....	2	2	...	...	....
New Hampshire	37	36	1	30	29	7	7	13	20	1	...	10
New Jersey	249	243	6	169	166	69	68	64	133	5	14	66
New Mexico	4	3	1	3	2	1	1	2	3	...	...	....
New York	661	623	38	484	462	180	147	214	394	19	14	188
North Carolina	66	66	....	61	65	5	2	48	53	1	...	18
North Dakota	5	5	....	5	5	.....	.....	3	3	...	1	2
Ohio	631	623	8	452	454	147	137	160	307	23	30	154
Oklahoma	24	16	8	23	16	1	.....	19	20	...	...	5
Oregon	43	42	1	39	38	3	3	22	25	...	...	8
Pennsylvania	851	836	15	672	666	131	135	287	418	25	73	180
Rhode Island	40	41	—1	27	27	12	12	10	22	1	...	7
South Carolina	31	29	2	31	29	.....	.....	25	25	...	...	7
South Dakota	7	8	—1	7	8	.....	.....	5	5	...	...	2
Tennessee	90	87	3	77	77	12	9	39	51	1	2	29
Texas	77	74	3	65	68	12	6	46	58	...	1	14
Utah	20	21	—1	19	20	1	1	13	14	...	...	5
Vermont	31	32	—1	26	29	5	3	19	24	...	...	8
Virginia	86	82	4	86	82	.....	.....	52	52	...	1	17
Washington	74	69	5	67	61	6	6	50	56	1	1	18
West Virginia	46	47	—1	42	44	3	3	27	30	1	2	8
Wisconsin	250	230	20	192	182	36	28	107	143	18	18	64
Total in the United States	6,037	5,812	*225	4,680	4,622	1,170	1,037	2,205	3,375	168	248	1,569
CANADA—												
Alberta	4	4	....	4	4	1	.....	3	4	...	...	2
British Columbia	18	19	—1	17	18	.....	1	17	17	...	1	3
Manitoba	11	12	—1	10	11	1	1	.....	1	...	...	2
New Brunswick	24	25	—1	20	21	4	4	13	17	...	...	4
Newfoundland	2	2	....	1	1	1	1	.....	1	...	...	.....
Nova Scotia	36	37	—1	32	33	4	3	18	22	1	2	5
Ontario	348	339	9	294	294	46	36	23	69	8	8	71
Prince Edward Island	4	5	—1	4	5	.....	.....	2	2	...	...	.....
Quebec	109	110	—1	94	95	13	13	37	50	1	5	23
St. Pierre et Miquelon	1	1	....	1	1	.....	.....	.....	.....	...	1	.....
Total in Canada	557	554	*3	477	483	70	59	113	183	10	17	110
Total in United States and Canada	6,594	6,366	*228	5,157	5,105	1,240	1,096	2,318	3,558	178	265	1,679

*Net increase.

TOTAL NUMBER OF FOUNDRIES IN THE UNITED STATES AND CANADA, 1908 AND 1910, BY STATES AND PROVINCES

418, New York is second with 394, and Ohio is third with 307. The other states follow in order: Illinois, 209; Michigan, 185; Massachusetts, 151; Wisconsin, 143; New Jersey, 133; Indiana, 119; Connecticut, 109; California, 106.

Among the leading foundry centers, Chicago again ranks first with 174, as compared with 131 two years ago. New York City is second with 148. Philadelphia third with 122, and Pittsburg and Detroit fourth, with 93 each. Erie, Pa., notwithstanding its comparatively small population, has a total of 28 foundries, while in the east, Worcester, Mass., has 22, Providence, 21; and New Haven, 18. The leading foundry centers of the United States and Canada, in the order of their rank, are given below:

	Total foundries 1910.	Total foundries 1908.
Chicago	174	131
New York City	148	118
Philadelphia	122	119
Pittsburg	93	83
Detroit	93	82
Cleveland	92	81
Cincinnati	76	70
Milwaukee	67	58
St. Louis	63	69
Buffalo	61	64
Newark	52	50
Boston	51	45
San Francisco	46	48
Toronto	42	37
Baltimore	41	38
Minneapolis	40	40
Indianapolis	31	31
Montreal	30	32
Birmingham	30	27
Louisville	28	30
Chattanooga	28	28
Erie, Pa.	28	27
Jersey City	28	32
Dayton	28	27
Toledo	27	27
Springfield, Mass.	25	26
Reading, Pa.	25	26
Rochester, N. Y.	24	21
Kansas City	24	22
Atlanta	22	21
Worcester, Mass.	22	21
Providence, R. I.	21	23
Bridgeport, Conn.	20	19
Portland, Ore.	18	20
Seattle	18	16
Racine, Wis.	18	15
Hamilton, Ont.	18	18
New Haven, Conn.	18	18

VARIOUS IRONS FROM ONE CUPOLA.

By W. J. Keep

Question:—We would like to obtain mixtures or analyses of strong, fluid iron for architectural castings, motor cylinders and other automobile castings, as well as glass house molds. The iron for the molds should be soft and close.

Answer:—Evidently all of the different classes of castings noted above are to be poured from the same heat and from the same iron mixture. This would be impossible. The architectural castings can be made of a mixture consisting of one-half or three-quarters machinery scrap and the silicon should be approximately 2 per cent. The percentage of phosphorus and sulphur can be fairly high so long as the castings are sound and can be readily machined. A small amount of powdered ferro-manganese in the ladle will lower the sulphur and prevent blow-holes.

Automobile cylinders are difficult to make, as so much depends upon the cores and the venting. The iron should be soft enough to machine, very close-grained, so as to wear well and not leak. The percentage of silicon should be close to 2.75, and the phosphorus about 1 per cent, to insure a fluid iron that will fill all parts of the mold. Much depends upon the patternmaker, and if there are any heavy sections, chills are frequently used to set the iron quickly and to prevent porous spots. The sulphur should be kept down to 0.05 per cent and manganese at least 0.5 per cent. Other automobile castings can be made from any machinery mixture, but the silicon should be about 2.25 per cent and the phosphorus, approximately 0.70 per cent. Glass house molds are a very different proposition. The silicon should be close to 3 per cent, while the sulphur should be very low. It is not an easy operation to run four different mixtures from one cupola on the same day, but it can be done. If you use very close-grained pig iron and clean, close-grained machinery scrap, with silicon about 1.75 per cent for your hard castings, you can add sufficient 50 per cent ferro-silicon to increase the total silicon content to 2.75 or 3 per cent and the grain of the metal will be closer than if this high percentage of silicon were contained in the pig iron. If there is any tendency toward blow-holes, add ½ ounce of pure aluminum to 100 pounds of iron. If you desire a very hard iron, add 2 to 5 pounds of spiegel-eisen to every 100 pounds of molten iron. By the use of these alloys you can meet all requirements satisfactorily with one cupola.

Acid Open-Hearth Slag

BY F. C. T. DANIELS

IN ACID open-hearth practice it is a well known fact that the quality of the steel depends on the composition of the slag. This slag is a chemical combination of iron as ferrous oxide, manganese as manganese oxide, and silicon dioxide, forming an iron manganese silicate normally of about 52 per cent silica and 43 per cent metallic oxides.

The ferrous oxide is obtained from the oxidization of the manganese in the charge, partly during the melting period, but mostly during the refining stage. Ordinarily the relative amounts of manganese and iron vary with the original charge.

The percentage of silica alone is a fairly good indication of the condition of the bath. If the silica in the slag is low, it can be said with certainty that the underlying steel contains an unsafe amount of dissolved ferrous oxide and is likely to be too cold to pour. This could have been brought about by an injudicious addition of ore or by too small amounts of silicon and manganese in the original charge. This condition can be remedied, if the carbon is sufficiently high, by the addition of silica in the form of sand, and by the raising of the temperature of the bath. The slag will thicken and adjust itself automatically. If the sand is not added, the necessary silica will be taken from the bottom and banks of the furnace, leaving them in a spongy condition.

The slag, when first formed, is low in silica and manganese and high in ferrous oxide. As the heat progresses, the silicon and manganese of the liquid charge are taken up by the slag until they are practically eliminated from the bath. At this point the carbon begins to burn off rapidly and may be seen bubbling sharply through the slag as carbon monoxide gas. After this, the silicon and manganese in the bath remain fairly constant; the carbon continually decreases, hastened by the addition of ore, until the specified percent-

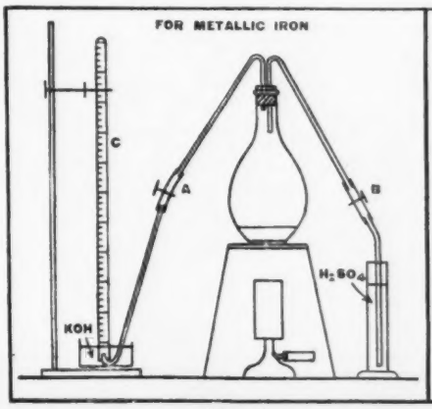


FIG. 1

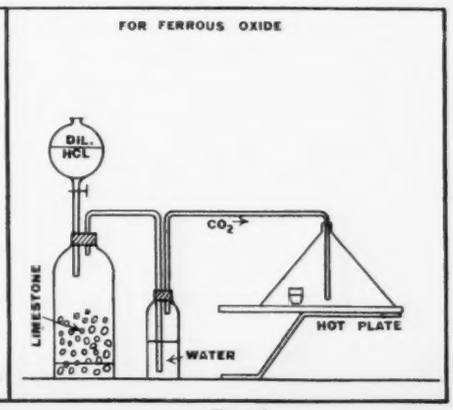


FIG. 2

age is reached, when the deoxidizers are added and the furnace tapped.

Frequently, after the silicon and manganese have been removed from the bath, they may increase again if the temperature is raised sufficiently and if the slag becomes very acid; the carbon of the steel will reduce the silicon from the slag, which will be dissolved by the bath. If the percentage of manganese in the slag is less than that of the iron, the bath will continually lose manganese until it is almost eliminated or until the percentage of manganese equals that of the iron. When the percentage of manganese is greater than that of the iron, the bath will gain in manganese.

It has been said that when the slag contains more manganese than iron, the bath will be free from the ferrous oxide. As this is the reverse of usual conditions in acid open-hearth practice, all steels contain more or less dissolved ferrous oxide. This is the impurity that is to be removed by the deoxidizers, silicon and manganese, which are added at the recarburization point. The condition of the bath at this stage determines the character of the steel—whether or not the ingots or castings will be free from blow-holes, and this can be ascertained by the analysis of the slag.

The following is a method for its analysis for silica (SiO_2), ferrous oxide (FeO), manganese oxide (MnO), ferric oxide (Fe_2O_3) and metallic iron. It does not claim ultimate accuracy, but it is sufficiently accurate to give the required information.

Silica.—Place one gram of the finely ground slag (100 mesh) in a 150 c. c. Griffin Jena glass beaker, add 10 c. c. hydrochloric acid (1.19 specific gravity) and stir immediately with a glass rod to prevent the slag from forming in a hard cake on the bottom of the beaker. Cover the beaker with a watch glass and place upon a wire gauze on a hot-plate. This gauze keeps the beaker from direct contact with the hot-plate and allows the mixture to evaporate to a dryness without spattering. After from 5 to 10 minutes, the slag will be mostly decomposed. Carefully add 5 c. c. of nitric acid (1.2 specific gravity) to oxidize the solution, then remove the watch glass and evaporate to a hard dryness. Cool the beaker and then moisten with a few drops of concentrated hydrochloric acid and again evaporate to dryness. After baking for 10 minutes, redissolve in 10 c. c. concentrated hydrochloric acid, dilute to 30 c. c. of hot water and filter. Wash twice with hot hydrochloric acid solution (one part acid to three parts water), then with hot water until free from acid. Burn the silica in a platinum crucible and ignite to constant weight. Cool in a dessicator and weigh as SiO_2. In most all cases this silica is strongly contaminated with iron and manganese and must be volatilized with hydrofluoric acid.

Metallic Iron.—Place 2 grams of the sample in a 500 c. c. ring-neck boiling-flask, add 50 c. c. of freshly distilled water and cork the flask with a rubber stopper containing two delivery tubes, *A* and *B*, Fig. 1, one of which, *B*, will serve to admit the sulphuric acid, and the other, *A*, to deliver the evolved hydrogen to the measuring tube *C*. Place the flask on a lamp stand over a lighted argand burner. Boil the contents until all the air is expelled from the flask and then close clamp on *A*, driving the steam through tube *B* for a minute. Place the end of *B* in a 50 c. c. graduated cylinder containing sulphuric acid (one part of concentrated acid to one part of water), close clamp on *B* and open *A*. Drive steam through *A* for a minute and place the end of *A* under the open end of an inverted 50 c. c. graduated tube which has been filled with dilute caustic potash solution, made by dissolving 10 grams of stick caustic in 100 c. c. of water. If no air bubbles collect in tube *C*, all the air may be assumed to be expelled from the flask and connections. Now close clamp *A*, remove the burner and when a partial vacuum has been formed, open *B* and allow 25 c. c. of the sulphuric acid solution to run into the flask. Close *B*, replace the burner and open *A* slightly. When the vacuum has been overcome, the hydrogen will pass to the tube *C*, and will be freed from hydrogen sulphide and carbon dioxide by the caustic potash solution and will collect at the top of the tube. When all the gas has been evolved, remove the tube *C* and place it in a tall cylinder of water. After a time, when the gas has assumed the temperature of the water, read the temperature, the volume of the gas and the barometric pressure. Correct the volume of hydrogen according to Liebermann's tables and from this calculate the percentage of iron in the sample.

Total Iron.—Treat 0.3 grams of the sample in a 20 c. c. platinum crucible with 5 c. c. concentrated hydrochloric acid. Stir the material with a glass rod. Remove the rod. Add 10 c. c. hydrofluoric acid and evaporate, on the hot-plate, to a hard dryness. Redissolve in 5 c. c. concentrated hydrochloric acid and transfer to a 150 c. c. Erlenmeyer flask, using about 25 c. c. of water in the operation. Add to the solution in the flask 3 grams of granulated zinc, also place a small funnel in the neck of the flask. When the action of the hydrochloric acid upon the zinc has ceased, add 20 c. c. dilute sulphuric acid, one part acid to one part water, and stand in a warm place until the zinc is dissolved. Fill the flask with cold water, forming a water-seal to prevent the oxidization of any iron. Set aside to cool. When quite cold, transfer rapidly to a large shallow white porcelain dish containing about a liter of distilled water and titrate immediately with twentieth normal potassium permangranate solution.

Ferrous Iron.—Treat, as before, 0.3 grams of the sample with hydrochloric and hydrofluoric acids, performing the operation very rapidly. Immediately place the platinum crucible on the cool part of the hot plate, under a large inverted funnel containing an atmosphere of carbon dioxide, Fig. 2. Fit the edge of the funnel to the surface of the hot-plate by grinding it with emery cloth. Cut off the stem of the funnel and pass carbon dioxide through a small glass tube inserted in the neck and reaching nearly to the bottom of the funnel. A rapid stream of carbon dioxide is maintained. Boil from 3 to 5 minutes; this will bring the slag into a complete solution. Transfer quickly to the titrating dish, containing a liter of distilled water and a fresh solution of three grams of zinc in an excess of sulphuric acid, and titrate, as before, with twentieth normal potassium permangranate solution. As metallic iron acts the same as the ferrous oxide in this analysis, the percentage of metallic iron, found in a previous determination, is calculated to ferrous oxide, and subtracted from the total found above to give the true percentage of ferrous oxide.

Ferric Oxide.—The total number of cubic centimeters of potassium permangranate used in the ferrous oxide determination subtracted from that used in the total iron determination, multiplied by the ferric oxide value of the permangranate, gives the weight of the ferric oxide in the three-tenths grams of the sample.

Manganese Oxide.—Dissolve 0.3 grams of the sample in hydrochloric and hydrofluoric acids and evaporate to a hard dryness. Redissolve in concentrated hydrochloric acid and transfer to a 250 c. c. Griffin beaker. Add 5 c. c. nitric acid (1.2 specific gravity), boil several minutes and then add 100 c. c. bromine water. Make the solution alkaline with ammonia water and bring gently to a boil, adding ammonia water from time to time, in order to keep the liquid alkaline. After boiling for a few minutes, remove the beaker from the hot-plate, let the contents settle, filter, and wash with hot water. Dry the precipitate and ignite over a strong blast in a platinum crucible. Cool and weigh as manganoso-manganic oxide (Mn_3O_4) plus ferric oxide (Fe_2O_3). Calculate the weight of ferric oxide present from the percentage of total iron found in a previous determination and subtract it from the total weight. Calculate the remainder to manganese oxide.

MOLDING CAST STEEL DRUM SHELLS

Method of producing these large steel sections, including a description of the spreading device, core boxes and pattern

BY H. J. McCASLIN

CAST steel drums are now being used extensively in the construction of hoisting machinery in place of cast iron, and while they are not of an intricate nature, the method of producing them is interesting and can be applied to many forms of annular castings. These drums or shells, when small in diameter, are usually cast with the arms or spider intact, but when large, the shells are usually cast and machined separate from the hub and arms, and afterwards assembled. To facilitate both handling and shipping, the shell and spiders, when large, are usually cast in halves and subsequently bolted or linked together.

The spiders can be cast in separate halves, but the shell has to be cast entire, for if cast in halves, the parts would be distorted by contraction and would not be circular when assembled. As the shell has to be cut and the cut surfaces machined, stock must be allowed for this operation and instead of being circular, the shell will be oblong when cast.

The metal allowance amounts to not less than 1½ inches and the spindle centers will, therefore, have to be thrown when striking the bed and forming the mold. Fig. 6 shows a drum shell 11 feet in diameter and 5 feet long, cleaned and ready to be delivered to the machine shop for separation.

FIG. 1—CAST STEEL DRUM SHELL MOLD PARTIALLY COMPLETED

The Mold.

The mold was formed by the segment and sweep shown in Fig. 7, the cope and inside being formed by setting segment cores, shown in Fig. 3, these cores being correctly located at the bottom of the mold by a seat formed with the strike, *A*, Fig. 7, and at the top of mold by the core print, *B*, attached to the top of the segment.

A feature not always easy to determine in such jobs is the shrinkage allowance, for the size, section and form of the piece, as well as the nature of the mold, will often cause a decided variation. A section will shrink more in its height than in its diameter, due to the resistance offered the latter dimension by the internal sand cores. This sometimes cracks the castings, especially when they are thin. The danger of such trouble may be materially reduced by light ramming and by using a sand mixture as non-resistant as possible. Such annular castings, inclosing a dry and green sand core, usually show a variation in shrinkage ranging from 3-16 to 1-10 inch per foot, due to their size and section. The cause of this variation is so uncertain that no fixed rule can be laid down as to the exact amount to allow. Each particular job must be given individual attention and its success or failure depends largely upon the experience and judgment of the one handling it.

Contraction Allowance.

The allowance for contraction on this casting was 1-10 inch per foot in diameter, and ⅛ inch per foot across the face, and although this latter dimension was in a vertical position it was calculated it would not shrink the usual allowance of 3-16 inch per foot because of the retarding influence of the internal end flanges, and the casting proved that this allowance was sufficient, as all dimensions were approximately correct.

At *D*, Fig. 6, is shown the ¾-inch recess formed by the splitting core, which separates the link pads and flanges. These were diametrically opposite and did not cut into the shell thickness. Thus it will be seen that a strip of metal equal in width to the splitting cores was allowed to remain for separating, and ⅜ inch at each side of the recess for machining, making a total of 1½ inches, the amount the center of work was shifted when making the mold. The casting was fed by eight risers, the scars of which are shown at *E*, Fig. 6.

Laying Out the Work.

In making the mold, the first move is to lay out a full size radial section and mark off the position of the cores. Then lay out a part plan of the wheel containing the spread and the manner in which the two joint cores abut against each other; also lay off the segmental form of the cores and draw in the clearance to be allowed. It will be noted in Fig. 3, that while the overhanging print portion at the top of core is of circular form the back is flat or on the short chord line. This is done to simplify the making of the core and to provide a flat surface for convenience in drying.

Cores.

It was found best to use 16 cores to form the inner circle because it made them a convenient size and permitted the spider pads to be formed in the alternate cores, as eight pads were required on each end flange, as at *F*,

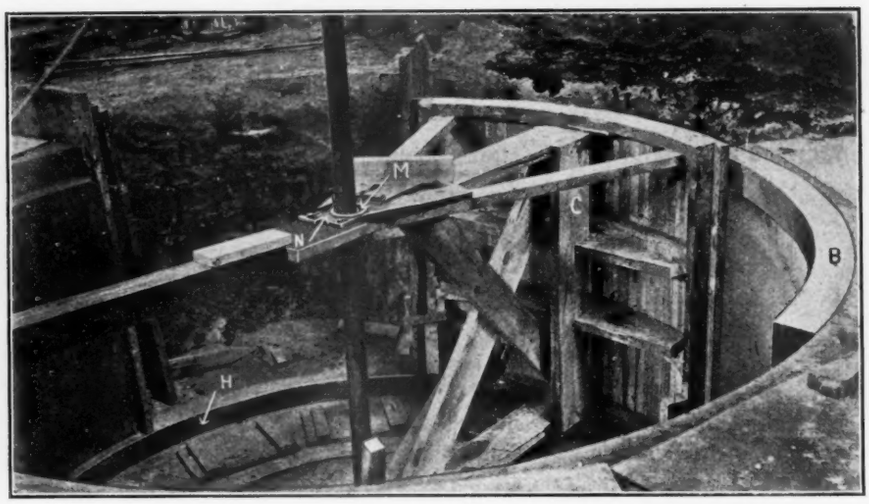


FIG. 2—VIEW OF THE SEGMENT PATTERN IN POSITION

Fig. 6. To take care of the amount of spread, the cores opposite the splitting joint, or those containing the link pads, are made in two parts which abut, as shown at *G*, Fig. 3, on a line with one side of the split core, which is fastened into one of the former.

Pattern Parts.

Fig. 7 shows the strike, *A*, used for striking up the core seat, *H*, Fig. 2, at the bottom of the mold, and the segment, *C*, Figs. 2 and 7, forms the outer diameter. As this segment is subjected to much rough usage it has to be well constructed, and was, therefore, lagged up over four headers and the arms well braced. The core print, *B*, Fig. 2, which forms the upper setting for cores, is loose, and held in place by dowel pins inserted from the inside; it was thus possible to leave this print off until the ramming of the mold had reached that stage, making it more convenient for the molders; also by removing the dowel pins, the segment could be moved independently of the core print, as shown in Fig. 1, thus protecting the edge of the mold while the segment was rammed in its new position. At each side of the segment a guide block is attached, which engages the seat, *H*, Fig. 2, when shifting the segment about the spindle, thus locating it in its correct position upon the bed before the eccentric sleeve, *K*, Figs. 4 and 5, is dropped into place.

The assembled and separate parts of the spreading device are shown in Figs. 5 and 4. It is made up of three parts, the plate, *K*, which is secured with four bolts to the arms of the segment, *N*, Fig. 7, the flange collar, *L*, which is secured to the spindle with set screws and the eccentric sleeve, *M*, that receives the spindle and is in turn received by the plate, *K*, all parts being machined to a nice running fit. When two devices are used, one on each arm of the segment, it is necessary to scribe a center line on the spindle, so the collars, *L*, can be placed in their proper relation to each other. For reversing the sleeve, *M*, two ⅜-inch dowel pin holes are drilled diametrically opposite in the collar, *L*, as shown at *O*, Fig. 4, and the sleeve, *M*, has a corresponding dowel inserted at *P*, and as the sleeve has a ¾-inch throw, it will readily be seen that by forming one-half of the mold, with the sleeve in one position, then withdrawing it and giving it a half turn about the spindle, the dowel, *P*, engaging the opposite hole in collar, we will have spread the center of rotation 1½ inches. For withdrawing the sleeve two tapped holes are provided and bolts inserted, as shown in Fig. 4.

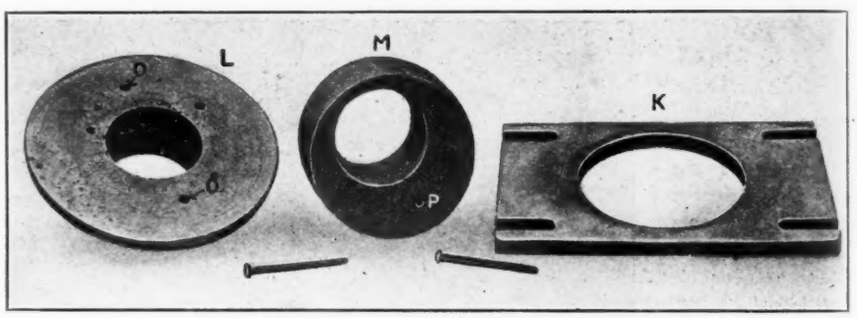


FIG. 4—VARIOUS PARTS OF THE SPREADING DEVICE

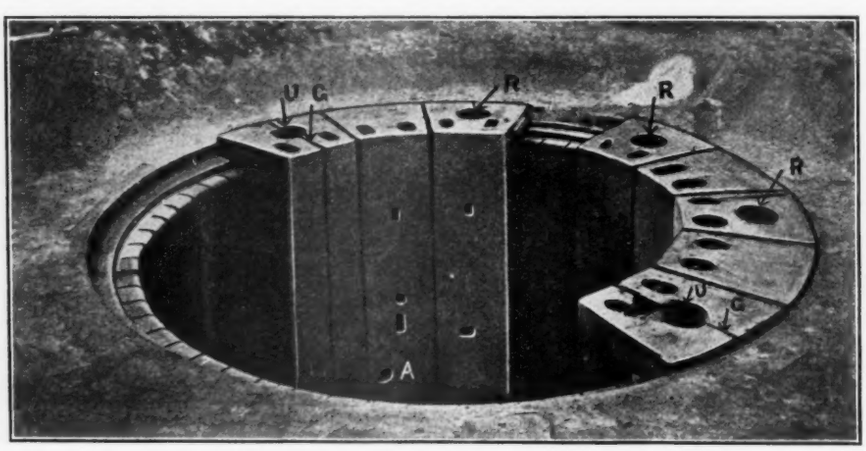


FIG. 3—THE DRUM SHELL MOLD SHOWING SEGMENT CORES IN POSITION

Core Boxes.

The core box for the segmental cores is shown in Figs. 8 and 9. It is a rectangular box, in which partitions can be dropped to form any shape of core required. This will be found an economical and practical core box, for with a good rigid frame, the different cores can be formed by suitable partitions. Fig. 9 shows the box set up to make 14 cores, six of which are plain and contain the riser openings, *R*, Fig. 3, which are formed by ramming up the block, *S*, Fig. 9, in its place. Fig. 8 shows the box set up for a joint core, of which a right and left, each containing an impression of one-half of the link pads, is required at the splitting joints. These cores are made one-half width by dropping in the partition, *V*, which is held in place by the end piece, *W*.

The core box, *X*, Fig. 8, makes the ¾-inch splitting cores, one of which must be secured between each right and left joint core. This is facilitated by the core print, *Y*, Fig. 8, which is attached to the partition, *V*, with loose dowel pins. The patternmaker should always provide for clearance between cores and also figure so their abutting surfaces will come together without rubbing or filing on the part of the molder

Fig. 3 shows the clearance allowed between the cores quite plainly.

Making the Mold.

The first step in making the mold was to excavate a hole sufficiently deep to bring the top of the cores level with the floor, and large enough in diameter to allow 12 inches of sand to be rammed between the segment and the wall of excavation. After the hole was made, the spindle socket was firmly set and the spindle plumbed. The collar, *L*, Fig. 4, was next adjusted and secured to the spindle sufficiently high from the bottom of the hole to permit sweeping the bed. The eccentric sleeve, *M*, was next dropped into place, and the sweep, *A*, Fig. 7, placed over the spindle. As the sweep had only one bearing on the spindle, it was necessary to bed-in a ring to support the sweep while striking-off this surface. When one-half of the bed is struck-off, the sweep was given a half turn, as previously mentioned, and the bed completed. The plates, *K*, Fig. 4, were then accurately

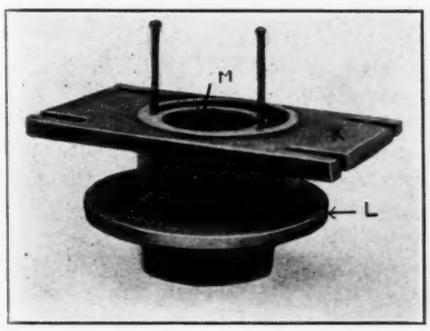


FIG. 5—THE SPREADING DEVICE ASSEMBLED

located and secured to the upper surface of the arms of the segment, which was then lowered down over the spindle and brought to position by means of the location blocks, which engage the core seat swept upon the bed. Rods were then adjusted until the accuracy of the spindle was assured, when the segment was placed with one end overlapping the splitting line about 1 inch, and the sleeve, *M*, dropped into place.

Facing the Mold.

The segment was braced against the opposite wall of the pit to enable it to withstand the pressure of the sand while being rammed. The mold was faced with a good grade of silica sand facing, about 1 inch, in thickness, and the sand walls were supported by being well rodded vertically at the bottom, and laterally under the core prints. The ramming was continued, section by section, until the mold was completed, when the segment was removed, but before disturbing the spindle, the surface of the mold

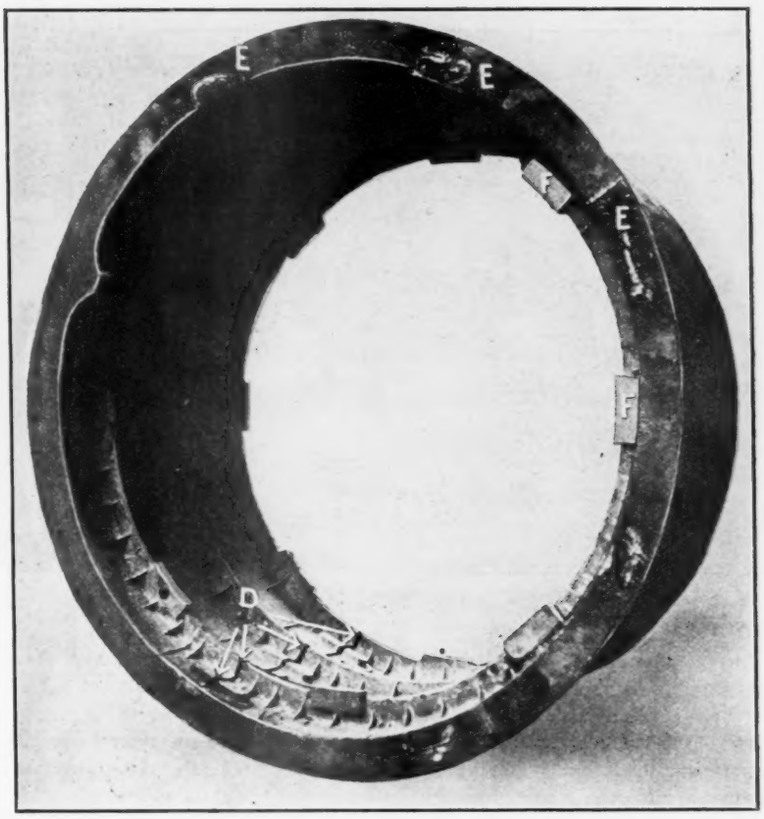


FIG. 6—LARGE CAST STEEL DRUM SHELL, 11 FEET IN DIAMETER AND 5 FEET LONG

should be measured with a gage stick, and any variations caused by the segment ramming in can be corrected with the trowel.

Next, with straight edge and plumb bob, the center line of split was marked on the mold. The rigging was then removed, the surface of the facing well nailed, coated with silica wash and the mold thoroughly dried with a coke fire

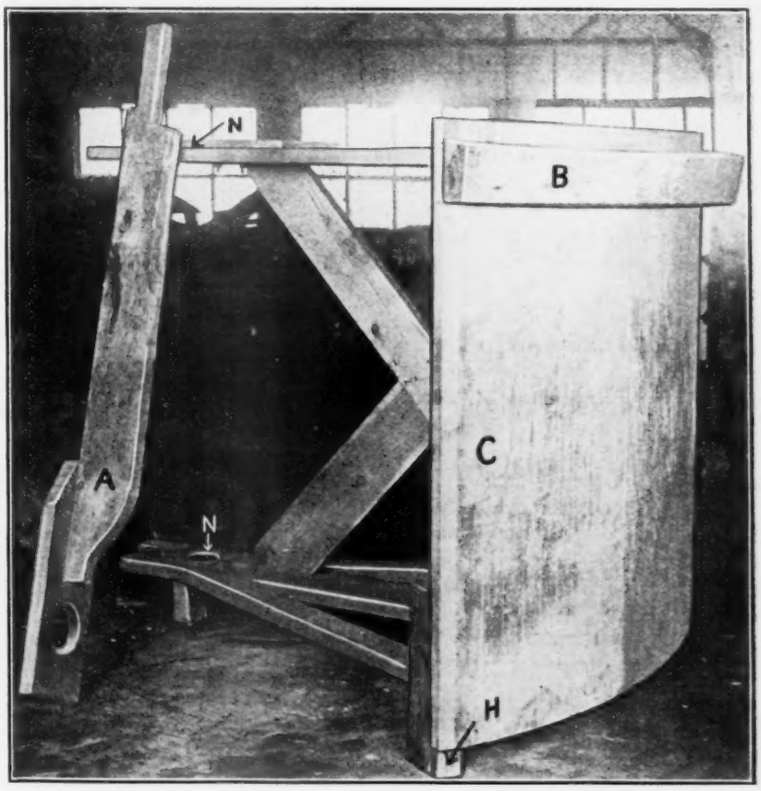


FIG. 7—SEGMENT PATTERN AND SWEEP USED FOR MAKING THE MOLD

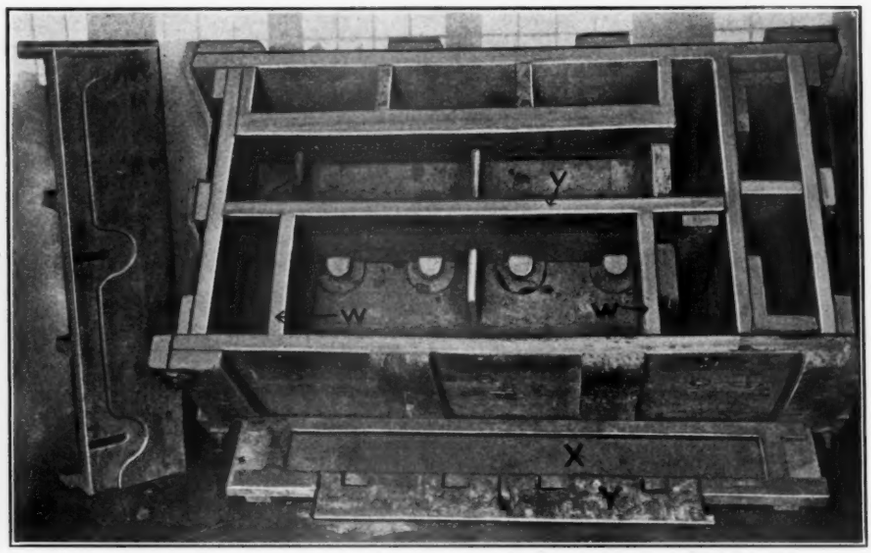


FIG. 8—CORE BOX ARRANGED FOR A JOINT CORE

In coring the mold, the half joint cores should be set first, for when these are correctly placed, the intermediate cores simply follow in order. A good plan to follow is to divide the core print into the same number of parts as there are cores. This shows at once if they are spacing correctly. When all the cores were placed, all unnecessary openings were closed with fire clay. The cores were then backed with sand, the gates, of which there were four, and the runner, were then formed. Four of the cores were provided with gate openings, *A*, Fig. 3, and when the ramming of the green sand core reached these openings, a parting was made and S-shaped channels cut from the openings in the cores to the center of the mold. These channels were faced with silica sand, well nailed, coated with silica wash, and covered with slab cores. The runner was formed of regular runner tile, rammed up in the center of the mold and carried 24 inches above the top of the cores and capped with a runner head. The backing was rammed firmly to about 4 inches above the gating, but from this point up it was rammed lightly, and at the top of the mold cores it was struck off and the holding down plates bedded. Then the riser heads were built, the supporting rails placed in position and the mold weighted. Fig. 1 shows the partially completed mold and in the background can be seen the risers, runner and tops of the cores of a shell already cast and in process of removal from the mold.

STAMP SHOES AND DIES.

BY W. J. KEEP

Question:—Can you give us a mixture for stamp shoes and dies used in crushers?

Answer:—Your mixture should contain about 1 per cent silicon, phosphorus not over 0.70 per cent, and the sulphur in the castings should not be over 0.06 per cent. Add about 2 per cent of spiegel-eisen to the mixture to give hardness and strength, and if necessary, this might be slightly increased.

DEOXIDIZERS FOR STEEL.

In all processes of steel-making, some of the metal becomes oxidized, and as the temperature of the metal approaches the point of solidification, the carbon contained in the metal reacts on the oxide of iron, reducing it and forming carbon monoxide gas, which causes blow-holes in the castings. As the reaction continues as long as any oxide is present in the molten metal, it is necessary to remove or neutralize it by some agent which will form a solid rather than a gaseous product.

The materials most commonly used are silicon, aluminum and manganese, and to these has lately been added silicon-calcium, in which the two elements are combined in such proportions that when they are both oxidized they form a very fluid slag. Both are very active reducing agents and the union of their oxides forms silicate of lime, which melts at or below 2,012 to 2,200 degrees Fahr., and which, being very fluid at the temperature of its formation, rises readily to the surface of the metal and enters the slag.

The silicon-calcium should be added in very small pieces, gradually, as the ladle fills, or it may also be added while pouring the steel if it can be thoroughly immersed. For ordinary low carbon steel the amount added varies from 0.1 to 0.2 per cent. For tire steel, containing 0.4 to 0.5 per cent carbon, as much as 0.25 per cent silicon-calcium may be used. For boiler plate steel 0.05 per cent has been found sufficient.

It is claimed that calcium has a tendency to unite with any sulphur in the steel, removing it from the metal as calcium sulphide, which passes off in the fluid slag. After this the remainder of the calcium, together with the silicon, unites with the oxygen. In this way the compound acts both as a deoxidizer and desulphurizer.

Silicon-calcium is made in the electric furnace and the average composition is given as follows: Calcium, 25 to 30 per cent; silicon, 65 to 70 per cent; aluminum, 2 per cent; and iron, 2 per cent. This alloy has been found useful in all classes of steel castings, open-hearth, small converter, and crucible.—*Foundry Trade Journal.*

FIG. 9—CORE BOX ARRANGED FOR FOURTEEN SEGMENTAL CORES

ENAMELED CAST IRON SANITARY WARE

The design and construction of the enameling furnace, with a description of the sifter used for applying the enamel

BY DILLEN UNDERHILL

THE department in which the enamel is applied to the cast iron ware is known as the enameling room. It is operated night and day to prevent the furnaces, in which the enamel is melted down onto the tubs, from cooling. When the furnace cools the bricks become loose as a result of contraction and the less frequently the furnace is permitted to cool the less frequently repairs have to be made. Furthermore, it requires about three days for the furnace to cool and practically the same time to raise it to the proper temperature when heated from a cold state.

Operation of the Furnace.

It is customary to employ three gangs of enamelers, who work in eight-hour shifts. The first turn of the week begins at midnight Sunday and ends at 8 a. m. Monday morning. The next gang of enamelers works until 4 p. m., and the third until midnight. No time is taken off for meals, which are eaten between heats. If heated by coal the furnace, on Sundays, is banked low enough to keep it at a cherry red heat. When heated by gas, the supply is reduced to accomplish the same result. When gas is used as a fuel the temperature can be regulated as desired. This feature is of great value to the enameler, no fireman being required, the foreman attending to the regulation of the furnace. Furthermore, the furnace can be quickly raised to its proper temperature and this heat can be uniformly maintained for long periods. The temperature of the furnace drops quickly and this is especially marked when a heavy tub is placed therein. If a peep-hole is provided in the furnace door, or if the door is left open slightly after the tub is placed in the oven, the color of the oven can be seen to change quite rapidly from a bright white color to a cherry red. This is the more noticeable when the tub is placed in the furnace to melt the slush coat. A rise in the temperature of the furnace and the tub requires a longer time than reducing the temperature of the furnace, which can be clearly seen through the peep hole or the opening of the furnace door.

Temperature of the Furnace.

Maintaining the proper temperature to melt the slush coat fast enough to make it unite with the iron is one of the difficult features of this operation. If the furnace is too hot it will burn off the slush, the enamel will not adhere, and chipping results. To my knowledge only one concern uses pyrometers to record the furnace temperatures. It is customary practice to depend upon the enameler to judge when the enamel has been melted. With the known advantages of the pyrometer for recording temperature variations, it is surprising that it is not used more extensively in this line of work. A recording dial, conveniently located so that the enameler can easily ascertain when his heat has come back, would undoubtedly materially increase production and the quality of the ware would be improved by withdrawing it at the proper time. Furthermore, if the ware should prove defective in service, a record of the heat would indicate whether the furnace was at fault. In addition, the records of the various heats would prove of value in obtaining data bearing on the proper enameling temperatures. These records might also show that a change in the design of a furnace might give better results.

In the article published in the April issue of THE FOUNDRY the operations were carried to the point of the application of the slush coat, which consists chiefly of dry sand and borax. This coating, when dry, is white and can be easily scraped off. Between heats the enameler inspects the ware, and if any small parts are uncovered, these are touched up with the slush. In the enameling room the tubs are set on end in rows near the furnace in which they are to be enameled.

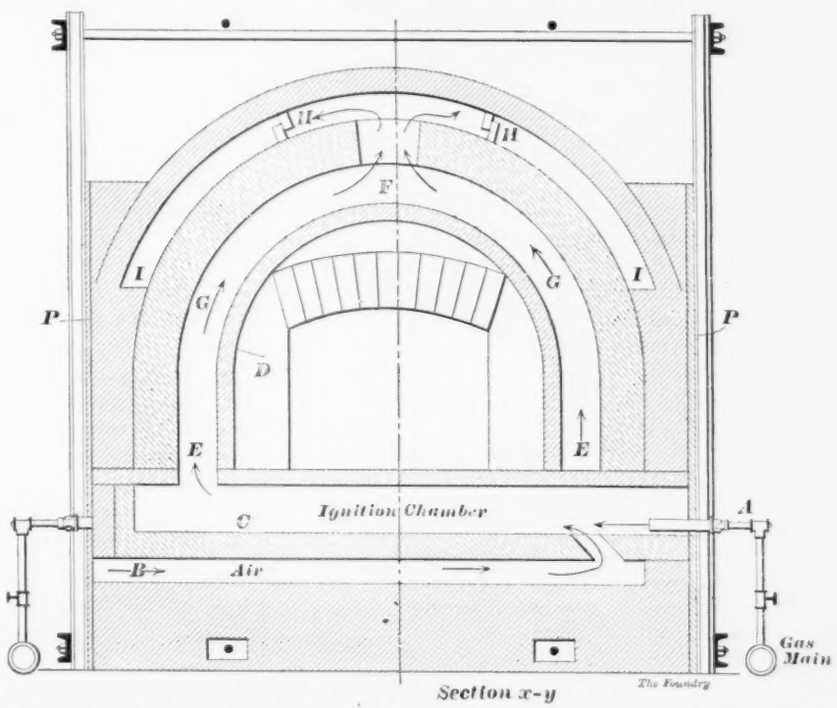


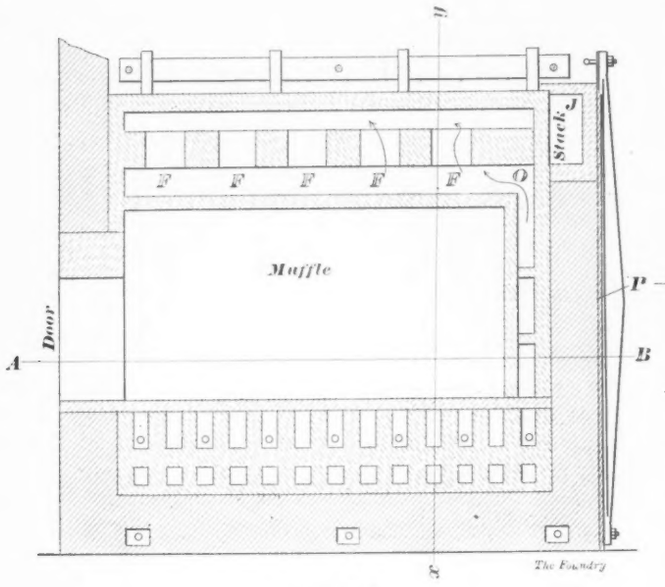
FIG. 1—CROSS-SECTION OF TUB ENAMELING FURNACE HEATED WITH NATURAL GAS

Placing the Tubs in the Furnace.

The tubs are place in the furnace by a fork which is made of a long section of 3-inch pipe with a T and a short length of pipe at one end, provided with a wrought iron or cast

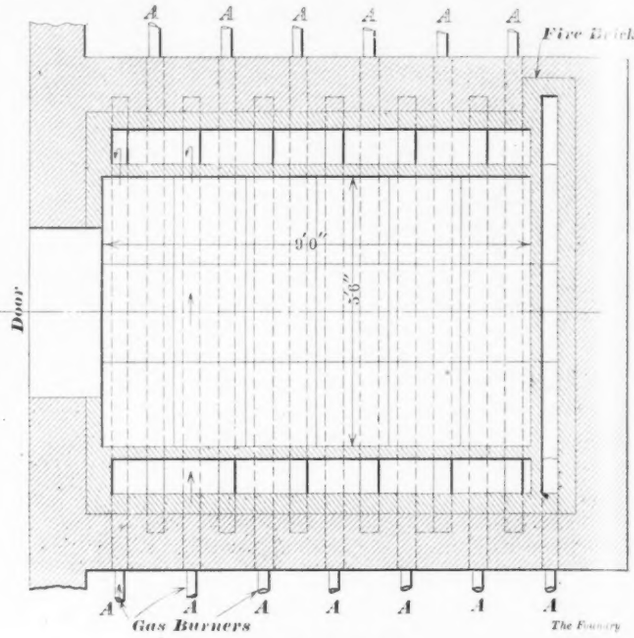
T to which the wrought iron fingers of the fork are attached. These prongs or fingers are adjustable to the width of the ware. The pipe is suspended at a point near the fork. complished by swinging the crane around on its pivot, while other slight variations from this movement are permitted by the chain itself. When constructing this crane, an ordinary pecially when a strut is set in place and tie rods are extended from the top to the bottom to strengthen the crane.

The tub is supported in the furnace



Section Z Z

FIG. 2—SECTIONAL SIDE ELEVATION OF NATURAL GAS FIRED TUB ENAMELING FURNACE



Section A B

FIG. 3—PLAN VIEW OF FURNACE FLOOR

This device is about 20 feet long, and when handling a tub weighing 250 pounds, the enameler balances about 80 pounds with his own weight when placing the tub into or removing it from the furnace. The fork is suspended by a chain from a jib crane which is made preferably of 4-inch pipe supported by round, wrought iron tie rods. The chain is attached directly to the extreme end of the arm of the crane and all of the necessary movements are ac-

pivot bearing at the bottom is advisable, while at the top a standard pillow block, turned sideways, gives satisfaction. As there is always more or less dust in the enameling room, the fine particles work into the more complicated bearings, making them turn hard and wear out quickly. A casting should be used, clamped to the upright post, and to this casting the horizontal arm is attached. No hole should be drilled through the upright post at this point of connection, es-

on two rails, either 40 or 60 pounds, to permit the heat to circulate around the casting. These rails also keep the tub in its original shape when it is raised to a white heat each time the slush or enamel coats are melted down.

Tub Supports.

As previously stated, the point of contact for the feet should be a uniform distance from the rest so that only one length of foot is required

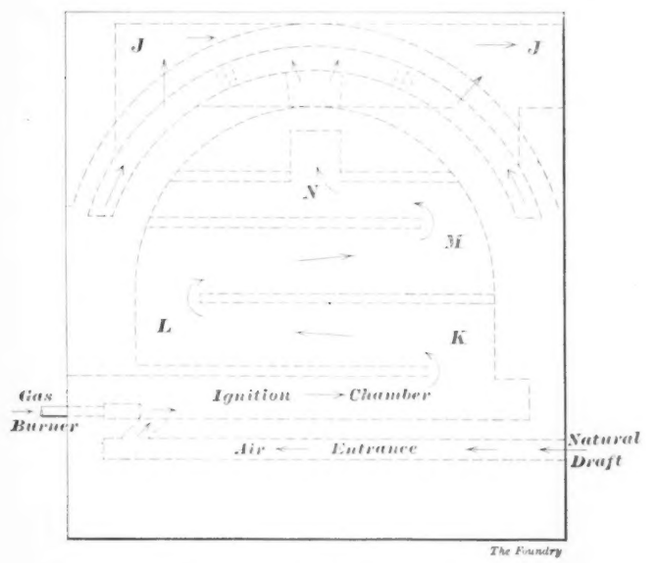


FIG. 4—REAR ELEVATION OF FURNACE SHOWING FLOW OF HOT GASES

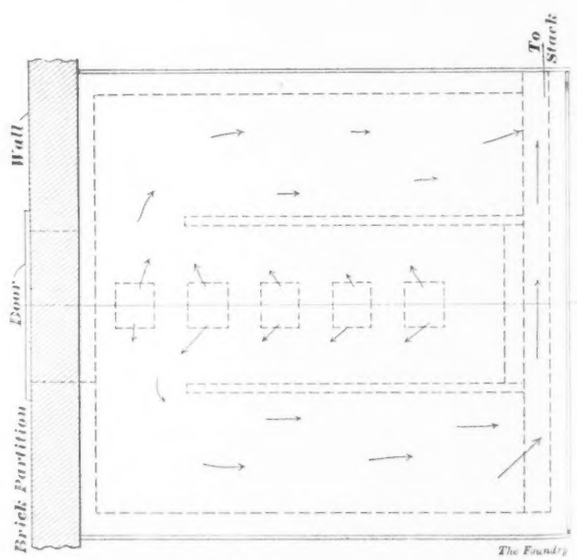


FIG. 5—END VIEW OF TUB ENAMELING FURNACE SHOWING FLOW OF HOT GASES ABOVE THE ARCHES AND TO THE STACK

The supports should be similarly curved when heating the tub, so that the support will be uniform throughout its entire length. Many concerns use cast iron supports, termed "bucks," which assume a large variety of shapes when used for supporting castings other than tubs in the furnaces. As sinks and lavatories are made with wide backs they must be heated either as they hang normally or with the backs tilted slightly forward, as these sections have a tendency to warp away from the bowls. This warping is so prevalent with ware of this kind that a machine is generally used to overcome this difficulty.

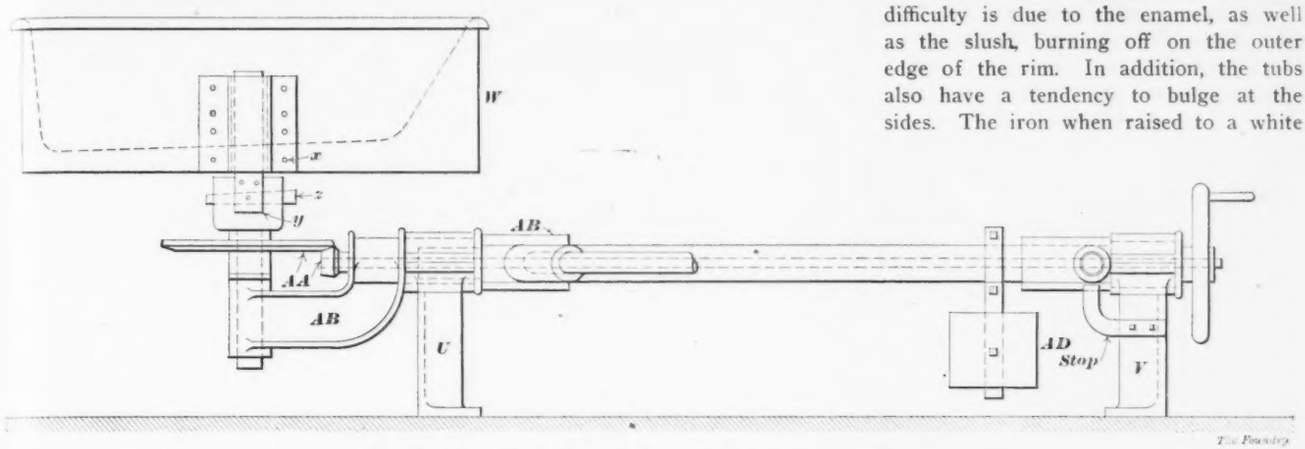


FIG. 6—SIDE ELEVATION OF THE TUB ENAMELING TABLE

Machines for Supporting Small Ware.

This machine is provided with a planed cast iron base with an opening in the center, through which the bowl is dropped. On top of this base a planed cast iron section is bolted so that the two finished faces are at an angle of about 85 degrees. A bar is placed across the front of the upright after the lavatory is in position, and each end of the bar is held by a hook. These hooks extend behind the upright and are a part of a cast iron bar which extends across the casting. A screw, operated by a hand wheel, passes through the center of the bar. The lavatory is placed in the frame, the bar is thrown across the casting, and by means of the hand wheel the back is pulled as straight as desired. This, however, can only be done when the casting has been given its slush coat, as the bar would make the enamel rough, and for this reason the back is tilted at an angle slightly more than 90 degrees, so that in case it springs back in subsequent heats it will still be square. A bowl sagging from the back presents a decidedly bad appearance when hung in place, and few are shipped that are not absolutely square.

Distortion of Tubs in the Furnace.

The tubs usually sag in the bottom when heated, as no support can be given at this point. For this reason a 5½-foot tub is inclined about ¾ inch in its entire length, and if the bottom sags in the enameling oven, the tub will still drain itself. Despite the fact that the bottom of the tub is inclined, if the casting is raised to too high a temperature, it will sag sufficiently to prevent all of the water from draining out. Another difficulty is due to the enamel, as well as the slush, burning off on the outer edge of the rim. In addition, the tubs also have a tendency to bulge at the sides. The iron when raised to a white heat is near its melting point and it has a tendency to spread out like a pasty mass. For this reason the rims are heavier at their extreme edges, and this, to a considerable extent, overcomes the bulging of the sides of the tub.

Enameling Furnaces.

There are a number of different types of enameling furnaces in use using natural gas, producer gas, coke, oil and coal for fuel. The natural gas furnace is easily controlled and the temperature can be more uniformly maintained than in any of the other furnaces named. All of the various types of furnaces are constructed with a view of having the flame pass entirely around the muffle, as indicated by the arrows in Figs. 1, 2, 3, 4 and 5, which also show the details of a tub enameling furnace. The furnace

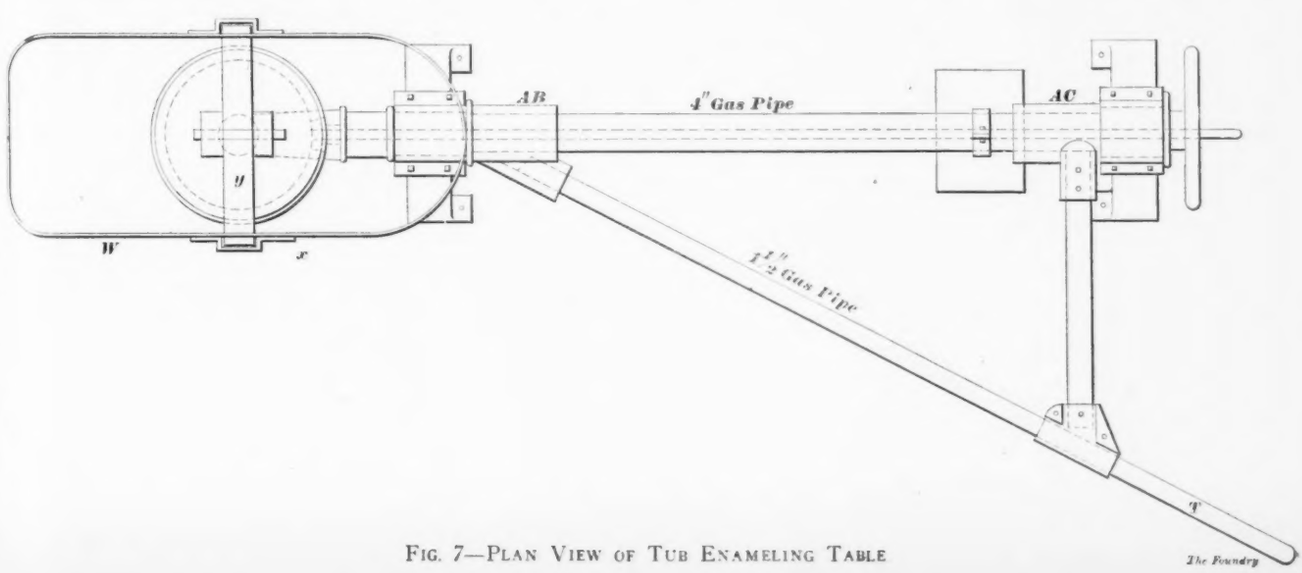


FIG. 7—PLAN VIEW OF TUB ENAMELING TABLE

illustrated is designed for natural gas as fuel.

Furnace Construction.

In Figs. 1 and 3, the gas enters the ignition chamber at *A*, and the air inlet is shown at *B*, Fig. 1, below the ignition chamber. It will be noted in Fig. 3 that the burners are placed alternately on either side, and the air, which enters the furnace below the ignition chamber, is preheated by the fire brick wall, *C*, Fig. 1, before it is mixed with the natural gas. The burner in use is of the Bunsen type, made of gas pipe with the end welded together, containing an opening, 3-32 inch, in the end. After igniting, the gases enter the opening, *E*, Fig. 1, and pass around the muffle, *D*, and into the stack through the opening, *F*. It is customary practice to entirely inclose this muffle, although some enamelers prefer the sides built straight, so as to choke the opening at *G*, while the top of the muffle is open. When the muffle is open at the top, there is always danger of dirt dropping onto the ware, but on the other hand, the enameling operation is facilitated. After the gases pass out through the passages, *F*, Fig. 2, they are carried to the front of the furnace, so as to pass around the partitions, *H*, Fig. 1. These partitions are built so that they will take up any unequal contractions of the arches. The partitions force the gases against the back, *I*, Fig. 1, and are then carried to the stack, which extends across the end of the furnace, as shown at *J*, Fig. 4. To keep the back end of the furnace hot, one burner is provided, as illustrated in Fig. 4. It will be noted that the gas passes back and forth at *K*, *L*, *M* and *N*, Fig. 4, and finally passes out at *O*, Fig. 2. Only one burner is required at the rear end of the furnace as the other burners heat the muffle sufficiently, the rear end absorbing enough heat to maintain it at the proper temperature. In some coal-fired furnaces this extra passage is dispensed with. In the illustrations, Figs. 1, 2, 3, 4 and 5, all dotted sectional lines indicate fire brick, while the red brick is shown in unbroken cross-sectional lines. In this type of furnace, the amount of brick required is reduced to the minimum. The sides are reinforced with cast iron plates, about ¾ inch thick, to support the brickwork. These plates are made in open sand molds and are inexpensive. They are shown at *P*, Figs. 1 and 2. Where the burners pass through the plates, square openings are provided, and to hold the plates in position 40-pound rails are used, and 6-inch channels with tie rods prevent them from spreading. To prevent the rear channels from moving, ¾-inch openings are drilled in the heads of the rails and pins are driven in position with approximately an inch projecting.

Brick For the Furnaces.

Special fire brick are used for the bottom of the muffle, each about 3 inches thick, 18 inches long and 12 inches wide. Common fire brick are used for the arches, while the entire muffle is made of cup brick, so as to carry the heat as quickly as possible to the inside of this chamber. The various sections shown are in correct proportion to each other, and inside the muffle, the dimensions are, 5 feet 6 inches by 9 feet, as shown in Fig. 3, the muffle having a 4-inch wall, while the fire brick arch is 13 inches thick. Furnaces somewhat shorter than the one shown, are used by manufacturers of small ware. For the large integral sinks with drain boards attached, a tub furnace is used, while for small lavatories the length may be reduced one-half. Estimating the cost of natural gas at 15 cents per thousand cubic feet, a tub furnace will consume about $100 worth of gas per month, and this may be reduced one-third if a smaller furnace will serve the purpose.

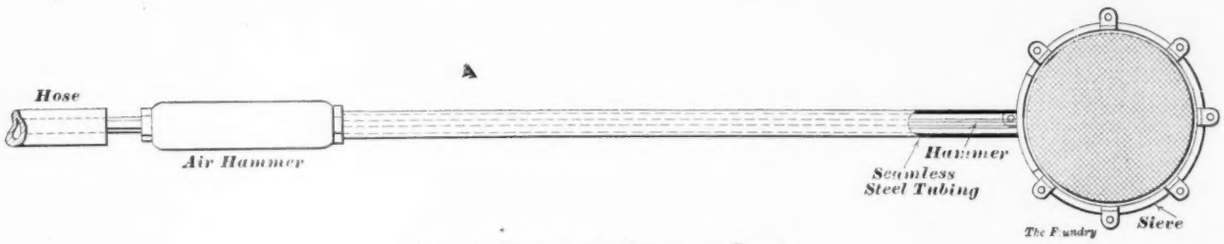


FIG. 8—PNEUMATIC SIFTER OR DREDGE

Furnace Charging Doors.

The furnace doors are both pivoted to turn on a hinge and counterbalanced so that they can be raised. The objection to a hinged door is that when it is opened it draws out the heat and in closing forces cold air into the muffle, thereby lowering the temperature considerably. The objection to the lifting door is that when the ware is placed in the furnace, there is always danger of dirt falling off onto the enamel. Both types are used, however, the doors being made of cast iron, lined with fire brick.

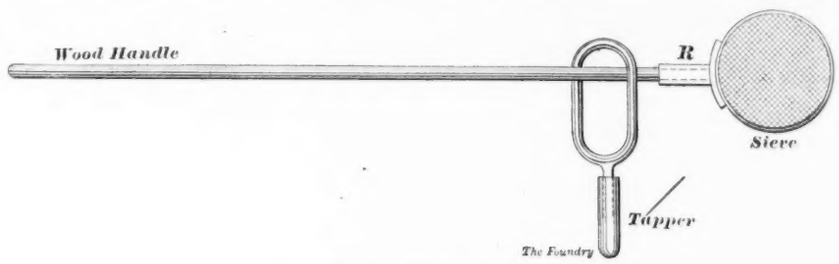


FIG. 9—HAND SIFTER

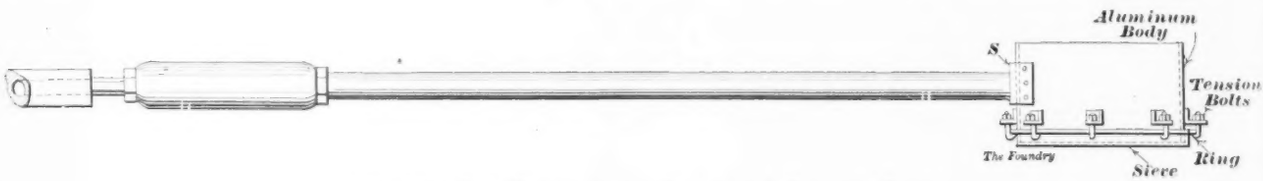


FIG. 10—SIDE ELEVATION OF PNEUMATIC ENAMEL SIFTER

The same type of furnace is used for both producer gas and oil. Natural gas, however, is desirable wherever it can be obtained. Coke furnaces are used in some plants, and while they are more expensive to operate than the gas-fired type, excellent results are obtained with furnaces of this design. The

coal-fired furnace is similar in construction to the gas furnace, the fire base extending along one entire side. However, when installing these furnaces in a row, they should not be built right and left, as the heat from the furnaces makes it impossible for the firemen to work, especially during the summer months. In these coal-fired furnaces, the heat is carried directly under the muffle and passes up each side, as shown in Fig. 1, the fire base being placed below the floor level.

Gas Passages.

Another method of conveying the gases is to carry them underneath the muffle to the opposite side, and they then pass over the top of the muffle to the skew back of the fire base through a series of openings in this back, passing over the second arch, through another series of openings on the other side of the skew back, to the stack, which extends along the side instead of at the end, where the stack is placed in a natural gas furnace. The gases, therefore, do not pass around the fire base side of the muffle, but the heat being so intense, the lower end of the muffle, near the fire base, keeps this side amply heated.

Applying the Enamel.

After the ware has been heated, it is placed on a table and is sifted onto the castings. A pneumatic sieve is used, but formerly a hand sifter or dredge, Fig. 9, was employed. The hand sifter consisted of a circular metal frame, to the bottom of which was attached a ring, into which was fastened brass wire cloth of about 40 screen. To the metal body was riveted a casting, *R*, with a cored opening for the insertion of a wooden handle. The casting was riveted to the bottom of the sieve. An elliptical section of iron provided with a wooden handle constituted what was known as a tapper. The enameler, after filling the sifter, grasped the handle of the sieve with one hand, the tapper with the other, and holding the sieve over the ware, hit the handle with the tapper, thereby dusting the enamel onto the casting. This dredge is still in use in some plants and is counterweighted to facilitate the work. However, a short handle must be used and the enameler must, therefore, do his work at a point close to the hot ware; furthermore, the enameler can only use one hand to support the dredge, the other being used to vibrate the tapper, and, therefore, only a small amount of enamel can be applied without refilling the sieve. The process, therefore, requires considerable time and two enamelers are required to apply the enamel to the large tubs, as otherwise they would become too cold to hold the enamel.

Pneumatic Sifter.

The penumatic dredge has taken the place of the hand sifter, and is shown in Figs. 8 and 10. The body of the sieve is made of aluminum, to which angles are riveted with openings at their projecting ends. Brass wire cloth, 40 to 60 mesh, is placed over the bottom of the body, and a ring is drawn up over it, so as to hold it firmly in place. A wrought iron plate is fastened to the body at *S*, Fig. 10, and to this is attached a section of seamless tube, at the other end of which is fastened a vibrator. This vibrator consists of a steel rod which contacts with a rapidly oscillating plunger transmitting the vibration to the plate, and this in turn vibrates the sifter. This plate should be of considerable thickness, as otherwise the constant hammering will soon distort it. These vibrators can be purchased from manufacturers of penumatic tools. The air hose is attached at the end, as shown.

Measuring Box.

In some plants, the enamel is accurately measured when placed in the sieve. The box which is used consists of a hopper and underneath is located a cylinder having six compartments. At the end of the cylinder shaft is attached a wheel, having six notches, in which a pawl engages, and attached to the pawl is a bent lever that swings below the cylinder. This lever is so pivoted, that by pushing it back with the body of the dredge, the cylinder revolves and permits a charge of enameling powder to fall into the dredge.

Enameling Table.

It is difficult to describe a typical table for enameling, as almost every manufacturer has a different type in use. The machine shown in Figs. 6 and 7 has given excellent service and is largely used for enameling tubs. A somewhat similar device is used for small ware with the arm, *T*, Fig. 10, omitted. The pedestals, *U V*, are not located so far apart and a large wheel with handles is placed between the wheel, *W*, and the pedestal, *V*. This wheel is attached to the same casting to which the arm, *T*, is riveted, and serves the same purpose.

The tub enameling table consists of a sheet steel casing, *W*, which is bent to fit underneath the rim of the tub. To both sides are riveted plates, *x*, into which a fork is loosely fitted. This fork is about 4 inches wide, ¾ inch thick and is held in position by a wedge. For tubs of different sizes, the casing is removed by driving out the wedge. Below the yoke is placed a pair of bevel gears. This arrangement sheds the enamel and permits the enameler to work entirely around the tub. The combined bracket and bearing, *A B*, can be set low, thus bringing the tub close to the floor. This casting extends through the pedestal, *U*, and forms a joint with the 4-inch gas pipe, which forms a joint with the other castings, *A C*, Fig. 7. A 1½-inch shaft passes through the center of this pipe and is connected to the small bevel gears, *A A*, and the hand wheel; *A D*, Fig. 6, is a counterweight for balancing the tub, which is moved back and forth on the 4-inch pipe. It can also be raised and lowered on the bar on which it is supported. The tub is set in the casing and is held in position by its own weight. It is then tilted on its side to permit the enameler to sift on the enamel. On the opposite side, a helper sifts the enamel onto the rim. The tub is then turned in various positions to permit the enameler to apply the enamel to the various parts. When entirely coated, the handle, *T*, is dropped back against the stop on the outer pedestal and the tub is lifted off with the fork and placed in the furnace. Customarily, two or three coats of enameling powder are applied and when finally removed from the furnace, the tub is placed on the enameling table and inspected. If the coating is satisfactory, the tub is placed on a truck and is conveyed to a room, where it is permitted to cool slowly. After the tub is removed from this room, it is again inspected and crated for shipment.

SEMI-STEEL GEARS FOR TRACTION USE.

By N. W. Shed

Question:—We would like to have a good semi-steel mixture for gears for traction use.

Answer:—A good mixture for these gears should carry about 25 per cent steel scrap. This can be made of pig iron, machinery scrap and steel scrap. The pig iron should have approximately the following analysis:

	Per cent.
Silicon	3.25
Sulphur	0.04
Phosphorus	0.50
Manganese	0.75

Use about 50 per cent pig iron, 25 per cent machinery scrap, 24 per cent steel scrap and 1 per cent ferro-manganese in the cupola. Have the metal hot. The semi-steel should have approximately the following composition:

	Per cent.
Silicon	2.00
Sulphur	0.10
Phosphorus	0.50
Manganese	0.60
Graphitic carbon	2.40
Combined carbon	1.00

PHYSICAL PROPERTIES OF CAST IRON*

A discussion of the effect of sand, chills, casting temperature, rate of cooling, etc., upon the structure of gray iron

BY F. J. COOK

THE foundation underlying the scientific use of cast iron in the foundry is now admitted to be chemical analysis, and it is to the credit of this Institute that one of its members, Prof. Turner, has been one of the greatest pioneers in the application of this science to practical working. Where the castings are light and have an even rate of cooling, their physical properties are entirely governed by chemical analysis and casting temperature alone; but as the size becomes larger, and the design is such as

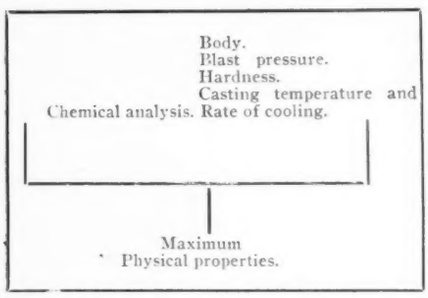


FIG. 1—DIAGRAM SHOWING FACTORS TO BE CONSIDERED WHEN MIXING IRON

to make it more difficult to insure an even thickness of metal and the same rate of cooling in all parts, chemical analysis alone has not the same governing power, and, therefore, other matters have to receive very careful consideration in conjunction with it, if the highest physical properties of the metal are to be obtained.

In works where high class engineering castings of medium and large size are made, I know of many instances where chemical analysis has been discredited, owing to the fact that chemists have been employed to regulate the iron, who, although able to make careful analyses of the metals used, have known little or nothing of the other ruling factors, and so, relying on chemical analysis alone, have caused much trouble and loss.

The diagram, Fig. 1, gives what I consider are the ruling factors to be taken into account when mixing iron for the class of castings previously mentioned, and I hope to show that it is necessary for chemical analysis to be wedded with correct rate of cooling, proper casting temperature, right degree of hardness or density, proper blast pressure when melting, and the metal to have good body, if the resultant castings are to be combined with the highest physical properties. The term "body" is used in the same sense as the Sheffield crucible steelmakers use it, to express that something, which is at present not shown by chemical analysis, but which greatly affects the physical condition of the metal.

The physical properties of two castings, or two parts of the same casting, cast with the same metal, will vary in direct relation to the rate of cooling, even though the chemical analysis of the two finished castings are alike. This effect is shown very plainly in Fig. 2, which represents a wedge, cast on end—the thin end downwards—with metal rather low in silicon and total carbon, suitable for strong castings about 2 inches thick. When the casting was broken the fracture ranged from close-grained white iron at the thin end, to open grain and spongy at the other, with varying degrees of closeness in between. Hardness tests were taken by the drill method, at the various points shown, and the results obtained are represented by the figures 70, 56 and 40. The chemical analyses of samples taken from different points gave identical results. Figs. 6, 7, 8, and 9 are micrographs, at a magnification of 150 diameters, taken from different parts, and show more clearly the difference in structure at the various points.

FIG. 2—CAST IRON WEDGE, WHOSE PHYSICAL PROPERTIES VARIES IN DIFFERENT SECTIONS WITH THE VARIOUS RATES OF COOLING

Micrographs.

Fig. 6 gives the characteristic structure of white iron, being very close and very hard, with extremely small flakes of graphite in a matrix of ferrite, which, however, are too small to be discernible at this magnification. The ground work will be noted to be composed of equal proportions of ferrite and cementite. The phosphide eutectic is also so broken up as to be scarcely discernible, although traces of it can be seen in the larger areas of cementite; this shows the metal to be extremely hard and brittle.

Fig. 7 shows medium-sized flakes of graphite in a matrix of ferrite, intermixed with a fairly large number of small areas of cementite, in which can be seen the phosphorus eutectic. The edges of the cementite areas are fringed with pearlite, and the general structure is that of strong, close-grained iron.

In Fig. 8 it will be seen the graphite is taking the form of long flakes, and that there is a much less proportion of cementite, showing it to be much more open-grained and softer than the

*Presented before the Staffordshire Iron and Steel Institute.

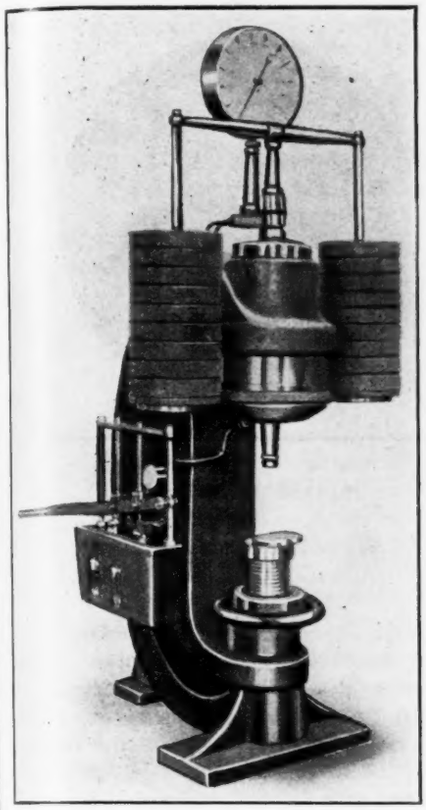


FIG. 3—BRINELL DRILL TESTING MACHINE

previous specimen, and consequently weaker.

Fig. 9 shows extremely long, thin flakes of graphite, some of them stretching right across the area under observation, and the amount of cementite has become very much less than in any of the three previous specimens; there are also very plainly shown the outlines of several crystals, showing it to be an extremely weak and unsuitable iron where strength is required. The cause of the flakes of graphite being so thin is due to the low percentage of total carbon and silicon.

Sand.

This experiment gives a graphic idea of the effect on the structure of cast iron due to different rates of cooling, whether that be brought about by abnormal different thicknesses of metal, in the various parts of the same casting, or owing to the design being such as to require very congested cores, from which it is difficult to extract the heat quickly. Sand as used for cores and molds, it must be remembered, is a very poor conductor of heat, and I know of instances where parts of important castings have been weakened very considerably, owing to the fact that the metal in these parts had been kept at a critical temperature—in cooling down—for a sufficient length of time to bring about a similar change of structure to that shown by the wedge, with a subsequent decrease of strength. These are two points in connection with different rates of cooling in the same casting, which very seldom receive the careful attention from designers that they deserve.

Effect of Chills.

The great effect on strength brought about by different rates of cooling is easily proved, by either casting from the same metal, bars of various sizes, or by casting bars of the same size and varying the rates of cooling by inserting in the molds, iron chills of various thicknesses. Table I gives several series of tests by the latter method. Each series of bars were cast in the same mold, and from the same ladle of metal.

Table 1 shows that in every case the difference in rate of cooling has had a very marked effect upon the strength of the castings. Figs. 10 and 11 show micrographs at 150 diameters of the bars unchilled and with ⅜-inch chill.

Casting Temperature.

For many years the question of what is the best temperature of iron at which to pour castings, to insure having the highest physical qualities, was a debatable one, and many experiments, more or less of an empirical nature, were carried out. From these it was found—and it is now universal practice—that for all castings where high strengths and closeness of fracture are desired, the metal must be

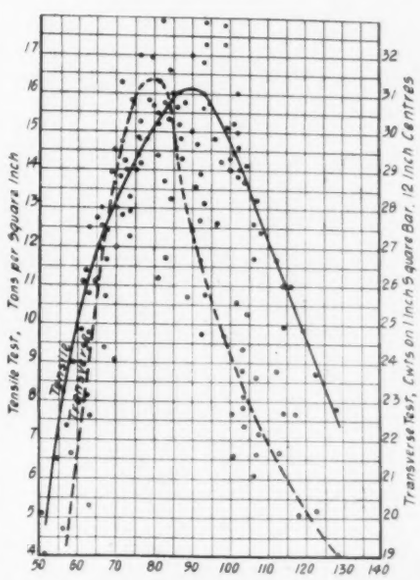


FIG. 4—DIAGRAM OF HARDNESS OF GRAY IRON BY DRILL TEST

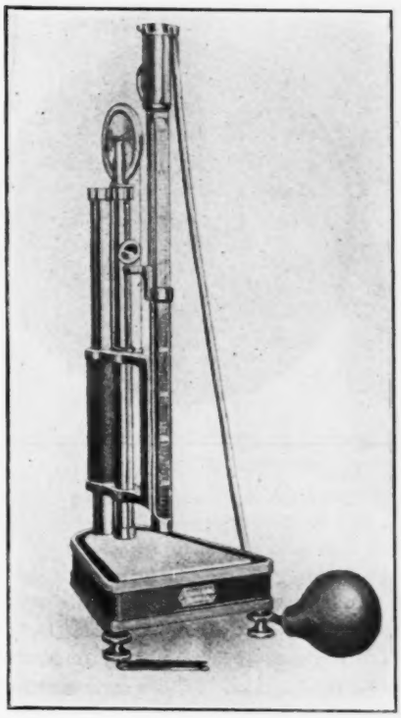


FIG. 5—REBONDIMETER HARDNESS TESTER

poured at as high a temperature as can be had from the cupola, without the metal being actually on the boil.

A very exhaustive series of experiments were carried out a few years ago on scientific lines by Percy Longmuir, to prove the proper casting temperature. The results were presented before the Iron and Steel Institute, for which he received a special Carnegie medal.

Many kinds of metal were experimented with, and each showed conclusively its susceptibility to the influence of casting temperature, which in many cases proved to have a very great influence on the physical properties of the castings tried.

In no experiment did the influence of varying casting temperature fail to show, and none of the forms of after treatment that he adopted, and to which the bars were subjected, such as annealing and re-heating, etc., brought the metal to a uniform level.

Owing to the agreement over a wide range of composition of cast iron, it is unnecessary to give but two results. I have therefore chosen first a typical white iron, such as is used in malleable iron work. The second selected is an ordinary gray iron such as is in general use. The results are embodied in Table II.

It will be noted that the first set of bars, which were all cast from one crucible, gave tenacities of 10.7, 15.9 and 12.1 tons per square inch respectively, and the companion bars, after undergoing an annealing treat-

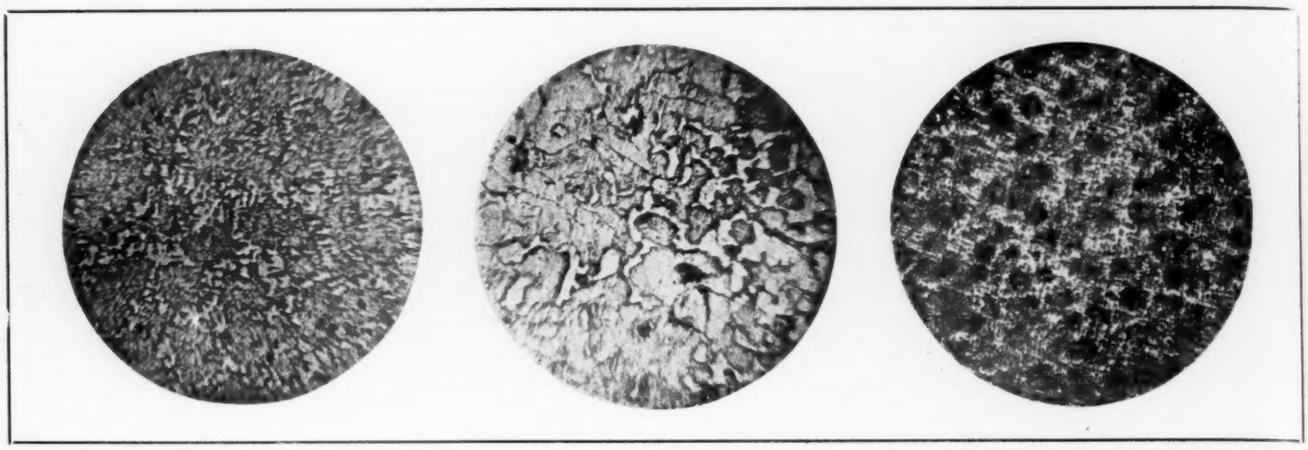


FIG. 6—MICROGRAPH SHOWING CHARACTERISTIC STRUCTURE OF WHITE IRON
(Magnification, 150 Diameters)

FIG. 7—MEDIUM-SIZED FLAKES OF GRAPHITE IN A MATRIX OF FERRITE
(Magnification, 150 Diameters)

FIG. 8—FLAKES OF GRAPHITE LONGER THAN IN FIG. 7, AND THE METAL IS MORE OPEN-GRAINED
(Magnification, 150 Diameters)

ment sufficient to decompose the combined carbon and completely rearrange the structure, which was proved by micrographs, still exhibit a variation forcibly shown in tenacities of 20.6, 29.2 and 26.5 tons per square inch.

The gray iron is also noteworthy, as it will be seen that a fall in temperature of 50 degrees Cent. raised the maximum stress 4.4 tons, while a further fall of 105 degrees Cent. lowers it 5 tons. These results, which are typical of hundreds that have been made with cast iron alone, are sufficient to show the importance of casting temperatures.

In each of the examples given, it will be noted that it was the medium and not the highest temperature which was associated with the greatest strength, but this, rather than being contradictory to my previous statement, confirms it, as the medium temperature is about that obtained with good, hot cupola working.

The testing of metals for hardness is becoming very popular, and no investigation is now considered complete that does not include it. The degree of hardness, as shown by the various tests usually employed, has a marked relation to the strength of the metal, as Fig. 4 will show. This is a diagram of hardness—by the drill method—tensile and transverse test results, from consecutive daily working for three months, with cast iron of the same class, from which it will be seen that the strength increased with the hardness up to a point, and then fell away again.

Machines for Hardness Tests.

As this test is now considered to be so important, it may not be out of place to refer to some of the machines used for this purpose. These are the Brinnel ball and cone test, the rebondimeter, the sclerescope and drill test. The Brinell ball test machine shown in Fig. 3 consists of a hydraulic press acting downwards, the lower part of the piston being fitted with a steel ball, by means of which an impression is made on the surface of the specimen or object to be tested. The pressure is produced by means of a small hand pump, and is recorded in kilograms on a specially graduated pressure gage. In order to guard against any error in the gage, the machine is fitted with a special contrivance, which checks the indications on the gage, and at the same time serves to prevent any excess of pressure beyond the exact amount required.

This controlling apparatus consists of a smaller cylinder, directly communicating with the main cylinder, which is furnished with a frictionless piston. When this is loaded with weights corresponding to the amount of pressure required, the piston is pushed upwards at the moment when the required pressure is attained.

When testing specimens of iron or steel, the pressure must be maintained for about 15 seconds, but in the case of softer material, for half a minute.

The hardness numeral is then ascertained by dividing the maximum pressure by the spherical area of the concavity and comparing it with a table of hardness numerals which is supplied with each machine.

This method has great and palpable advantages, but also this disadvantage, that different hardness numerals will be obtained with the same metal if different pressure or a different diameter of ball is used. It will, therefore, always be necessary to state what pressure and what diameter of ball has been used, simul-

Table I.

Class of iron.	Analysis. Combined carbon.	Graphitic carbon.	Silicon.	Manganese.	Sulphur.	Phosphorus.	Thickness of chill, inches.	Maximum stress, tons per square inch.	Per cent gain.
Tough	0.234	2.8	1.96	0.5	0.11	1.1	—	11.6	
							1/8	15.15	30.6
							1/4	15.6	34.4
							3/8	White iron	
Ordinary engineer's mixture	0.103	3.16	2.52	0.28	0.01	1.3	—	9.8	
							1/8	11.2	14.3
							1/4	13.2	35.7
							1/2	15.2	55.1
							3/4	16.2	65.3
No. 3 foundry pig.....	0.094	3.190	3.366	0.231	0.025	1.522	—	8.1	
							1/8	11.9	46.9
							1/4	12.1	51.8
							3/8	15.2	87.6

FIG. 9—MICROGRAPH SHOWING LONG, THIN FLAKES OF GRAPHITE
(Magnification, 150 Diameters)

FIG. 10—MICROGRAPH OF UNCHILLED BAR
(Magnification, 150 Diameters)

FIG. 11—MICROGRAPH OF BAR WITH ⅜-INCH CHILL
(Magnification, 150 Diameters)

taneously with stating the hardness numeral.

To avoid this inconvenience, a proposal has been made by Dr. Paul Ludwig, of Vienna, to use, instead of a ball, a hard steel cone with a top angle of 90 degrees, the point of which should be pressed into the testing material. Owing to the fact that conical impressions, whether they are small or great, are always uniform in shape, the same hardness numeral—contact hardness—will, in accordance with Kick's law, always be obtained with the same material, without regard to the testing pressure used.

This method has, moreover, from a purely practical point of view, another considerable advantage. By means of a suitable arrangement the diameter of the impression may easily and accurately be read off while the test specimen still remains in the machine, and consequently without using a microscope.

Rebondimeter.

In 1906, Otto Tinberg, engineer to the Swedish Iron Works Co., Stockholm, constructed an apparatus, which he called a rebondimeter, the general arrangement of which is shown in Fig. 5.

It consists of a graduated glass tube, connected at its upper end with a device from which a steel ball is dropped when the rubber bulb attached to it is released. The ball drops through the glass tube, hits the specimen placed under the tube, and rebounds to a height which is read against the graduated glass tube. The rubber bulb should be pressed until the ball rests on the specimen, it is then released and by suction the ball returns through a special channel to its original place in the top of the apparatus.

The drop of the ball is 500 millimeters and the glass tube is graduated in one-thousandths of the total drop, zero point being at the bottom part of the tube. Test specimens of different heights up to 200 millimeters may be tested in the apparatus. To test larger objects, such as rolls, the rebondimeter is removed from its stand and placed vertically on the spot to be examined. A water level, with which the vertical position of the apparatus is controlled, is moved along the glass tube to about the height to which the ball rebounds. The level may then be observed by a small mirror simultaneously with the reading of the height of the rebound. The homogeneity of a material may be examined with accuracy by means of the rebondimeter.

Scleroscope.

A similar instrument has been brought out by Dr. Shore, called a scleroscope, the difference between it and the rebondimeter can be summed up as follows: In the rebondimeter the drop body is a 5-millimeter steel ball, weighing 0.505 of a gram, having a drop of 500 millimeters. The drop hammer of the scleroscope has a weight of about 2.1 grams and a drop of 10 inches. Consequently the rebondimeter ball strikes the test specimen with a stored-up energy of 0.505 by 500, 252.5 gram millimeter, while the scleroscope hammer 2.1 by 254, 533 gram millimeter, or more than double that of the rebondimeter ball.

It is claimed that when the scleroscope is used for testing very hard objects the striking point of the drop hammer is deformed owing to this extra energy, which alters the rebound. In consequence it is occasionally necessary to ascertain whether the striking point has retained its shape, which is done by making a test on a steel piece of standard hardness supplied with the apparatus, and if an alteration has taken place in the shape it is necessary to restore the point by grinding.

The drill method is to note the

Table II.

Analysis.								
Combined carbon.	Graphitic carbon.	Silicon.	Manganese.	Sulphur.	Phosphorus.	Casting temperature, degrees Cent.	Maximum stress, tons per square inch.	Condition.
3.4		0.39	0.05	0.20	0.02	1,321	10.7	As cast
						1,230	15.9	As cast
						1,120	12.1	As cast
0.2 to 0.5	3.2					1,320	20.6	Annealed for 100 hours.
						1,230	29.2	in ore.
						1,120	26.5	"
0.52	3.4	1.78	0.28	0.04	0.27	1,400	9.7	As cast
						1,350	14.1	As cast
						1,245	10.6	As cast

number of revolutions required to drill a hole, in the specimen to be tested, to a known depth, with a known weight acting upon the point of the drill, or to measure the angularity of a diagram which is made by a suitable

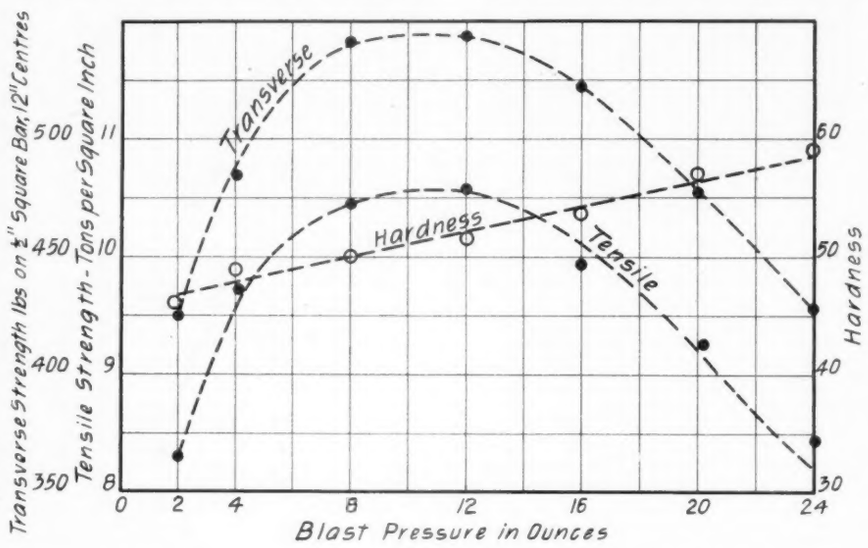


FIG. 12—DIAGRAM SHOWING THAT HARDNESS INCREASES DIRECTLY AS THE BLAST PRESSURE IS INCREASED

arrangement attached to the machine.

To call the ball, cone or drill test a hardness test is somewhat of a misnomer, because they do not necessarily indicate the quantity of hardening elements present in the iron. They are rather records of the resistance to penetration, and this is affected not only by the quantity of the hardening elements present but also very largely by the density or closeness of the metal. For instance, the analysis of the metal for hardness, 65 to 95 on the diagram, Fig. 4, was practically the same, varying from 0.5 to 0.6 per cent of combined carbon; other elements being normal, the difference in strength and hardness being attributed to slight variations in working, but largely to the rate of cooling. Some of the bars, although of the same diameter, were cast on small castings, while others were taken off very large ones, and from the result shown by the wedge, the closeness of the metal would be affected by this different rate of cooling and thus give a different resistance to penetration, although the analysis of the metal was practically the same. I have met with many instances of cast iron containing a considerably larger quantity of the hardening elements, but which have given a much lower hardness test result than that shown by irons containing less, but in every case, where a larger quantity of the hardening elements has shown a lower test result, it has been associated with iron showing a much more open grain and coarse fracture and graphitic carbon in considerably larger flakes. Typical examples are given in Table III.

The first three examples, although they contain a much larger quantity of the hardening elements, have given lower hardness test results than the last three, this being accounted for by the fact that as the crystals in the former were much larger, with larger flakes of graphite in between, the metal offered much less resistance to penetration than did the latter, of which the metal was more dense and compact.

Blast Pressure.

The question of blast in relation to pressure, temperature and dryness has received a great deal of attention in blast furnace practice, but in cupola working it has been sadly neglected by metallurgists and foundrymen alike. There is quite a wide field for investigation, and data on at least volume, is most essential before the working of the cupola can be put on a scientific basis. From the results of ten years' close attention to blast pressure and many experiments, I am quite convinced that the pressure of the blast when melting cast iron has a great effect upon its physical properties. Fig. 12 is a typical diagram obtained from a series of experiments, the one in question having been taken when melting No. 3 foundry pig iron. The diagram shows that the hardness increased directly as the blast pressure; the ordinates practically falling on a straight line. The transverse and tensile results show an increase in strength along with hardness up to a point and then fall away again. This is characteristic of all classes of foundry irons that I have experimented with, but with this difference. In the present case, the peak in both the transverse and tensile test result curves is coincident with the same blast pressure and hardness, in fact, both of the curves are practically identical, but as the irons experimented upon belong more to the harder class, so did the peak of each curve become more divided. With the harder irons, the peak of the transverse curve is associated with rather low hardness than that which gives the highest tensile results, an example of which is shown in Fig 4.

The alteration in chemical composition in the series of tests under consideration was as follows: Total carbon decreased from 3.4 per cent to 3.12 per cent in even stages; combined carbon, of which there was only a faint trace in the original pig iron, showed no perceptible increase up to 12-ounce blast pressure, then increased to 0.10 per cent at 16 ounces, 0.16 per cent at 20 ounces, and 0.26 at 24-ounce pressure. Sulphur increased from 0.01 per cent to 0.043 per cent, practically the same increase being shown in each test; phosphorus and manganese remained normal throughout, and silicon, of which the original pig contained 3.26 per cent, was rather erratic, and showed no regular tendency to increase or decrease.

The results of this series of experiments are sufficient to show the importance of attention to blast pressure, and although the effects will vary in accordance with the type of cupola used and class of iron melted, yet the tendency is always in the direction shown in this particular case.

Table III.

No.	Combined carbon. Per cent.	Sulphur. Per cent.	Manganese. Per cent.	Hardness by drill method.
1	1.2	0.097	0.504	61
2	1.7	0.109	0.288	55
3	1.33	0.1	0.504	50
4	0.84	0.09	0.4	79½
5	0.70	0.107	0.32	68
6	0.55	0.108	0.28	63

Body.

That irons of the same ultimate chemical composition give widely different tensile and transverse test results, is fairly well known, but the reason of these phenomena has not yet been put on a scientific basis. In a research on an introduction to the effect of structure upon the physical properties of cast iron, conducted by Mr. Hailstone and myself, and read at the British Foundrymen's Association convention in Birmingham last August,

we endeavored to show why these widely different results occur, and that the physical condition of the pig iron used, and a certain microscopical structure, other than the size of the graphite, is common to all strong irons.

Fig. 13 is a diagram of tensile test results of two series of casts, each representing 60 consecutive days' working, with irons mixed to give the same chemical composition, but each series made up with different brands of pig iron. That the chemical analysis was identical in each case was proved by analyses taken from time to time which, in each instance, for all practical purposes came out alike. It will be seen on reference to the diagram that the highest tensile result in the "A" series was lower than the lowest result in the "B" series. A summary of the whole of the tests taken is shown in Table IV.

Each tensile test bar, 1 inch square and transverse and hardness bars were cast relatively of the same size and on the casting they were to represent, while the ½-inch transverse bars which were also used for the shrinkage test, were cast separately by Keep's method. The transverse bars were cast 1¼ inch square, machined down to 1 inch square, and tested on 12-inch centers. The hardness test was taken by the drill method. Referring to Table IV, it will be seen that the results of the transverse tests on the 1-inch square bars also show a marked difference, as to the tensile tests. It will be noticed, however, that the average result of the transverse test on the ½-inch square bars is slightly in favor of the series which gave the weakest tensile and 1-inch square bar transverse results. As the methods of manipulation and the chemical composition of the two series had been the same, it was thought that a microscopical analysis would reveal a cause for the vast difference. For the first investigation, a low bar of the "A" series and the highest bar from the "B" series were examined. The chemical analyses of the two bars were first taken, as follows:

	"A" Tensile test. 9.1 tons per square inch.	"B" Tensile test. 19.3 tons per square inch.
	Per cent.	Per cent.
Total carbon	3.250	3.192
Graphitic carbon....	2.397	2.289
Combined carbon....	0.853	0.903
Silicon	1.328	1.314
Sulphur	0.095	0.101
Phosphorus	0.923	0.909
Manganese	0.290	0.335
Iron by difference..	94.114	94.149

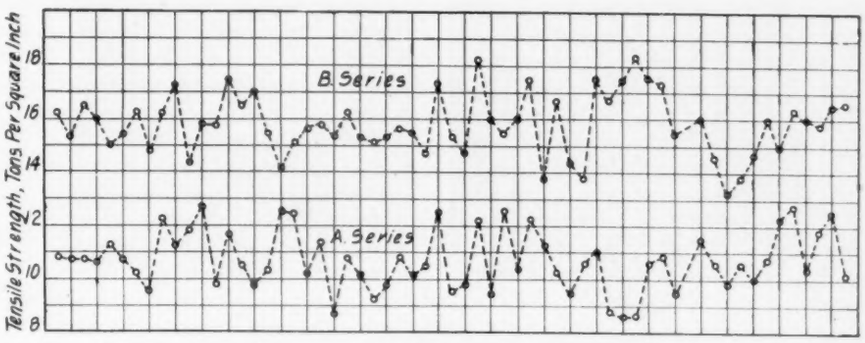


FIG. 13—DIAGRAM OF TENSILE TEST RESULTS OF TWO SERIES OF CASTS, EACH REPRESENTING 60 CONSECUTIVE DAYS' OPERATION

These analyses will be seen to be practically identical, even to the amount of the combined and graphitic carbon. To insure the results being absolutely comparative, micrographs were each taken from the same position, in other words, the center of the bars. These showed nothing very remarkable to account for such widely different physical results.

As it had been noticed with bars previously examined that those giving high test results had also been associated with a peculiar net-like structure, we were led to the conclusion that probably strength was associated with this structure independently of what the chemical composition might be. We therefore examined the third series of bars in Table I, which were made to show the effect on strength of different rates of cooling. For this experiment, four bars had been made in one flask cast from the same ladle of metal, which was ordinary No. 3 foundry pig iron. The rate of cooling was regulated by means of cast iron chills, of different thicknesses, placed in the molds for three of the bars, the other having no iron chill. The bar without the chill gave a tensile test result of 8.1 tons per square inch, while the bar at the other end of the series broke at 15.2 tons per square inch. These two bars were selected, the chemical analyses of which were as follows:

	Unchilled bar. Tensile strength, 8.1 tons per square inch.	Chilled bar. Tensile strength, 15.2 tons per square inch.
	Per cent.	Per cent.
Total carbon	3.284	3.280
Graphitic carbon....	3.190	3.190
Combined carbon....	0.094	0.090
Silicon	3.366	3.368
Sulphur	0.025	0.026
Phosphorus	1.522	1.524
Manganese	0.231	0.230
Iron by difference..	91.572	91.572

These results are identical, and as there is practically no combined carbon present there must be an absence of cementite. Micrographs showed elongated flakes of graphite in the unchilled bar and finely divided graphite in the chilled bar.

Since these results were given, the research has been further extended, with quite surprising results. In none of the bars examined, no matter what their composition has been, has there been any deviation from the theory. In every case, the net-like formation begins to show at about 12 tons tensile, and becomes more distinct as the strength increases.

The foregoing results, we think, have been sufficient to show that in each case, high physical properties have been associated with this net-like formation of the phosphorus, also that the graphite, when in the elongated form, appears to split up the phos-

Table IV.

Series.	Tensile test, tons per square inch. "A"	Tensile test, tons per square inch. "B"	Transverse test, hundredweights, 1 inch square bar, 12 inches long. "A"	Transverse test, hundredweights, 1 inch square bar, 12 inches long. "B"	Transverse tests, pounds on ½ inch square bar, 12 inch center, Keep's test. "A"	Transverse tests, pounds on ½ inch square bar, 12 inch center, Keep's test. "B"	Shrinkage in inches, ¼ inch square bar, Keep's test. "A"	Shrinkage in inches, ¼ inch square bar, Keep's test. "B"	Hardness. "A"	Hardness. "B"	Blast pressure in ounces. "A"	Blast pressure in ounces. "B"
Highest	12.9	18.3	28.5	32.25	550	570	0.182	0.180	68	78	15	16
Lowest	8.7	13.1	19.0	25.0	390	375	0.144	0.140	48	56½	10	11
Average	10.7	15.8	23.1	29.1	466	450	0.140	0.155	57½	64¼	12¼	13¼
No. tests taken	60.0	60.0	33.0	30.0	58	59	0.58	0.58	60	56	44	39

phorus-eutectic and prevents this formation.

Referring again to the summary of tests taken with the "A" and "B" series, it will be seen that the results of the ½-inch transverse bars of the "A" series, which gave weak tensile results, are slightly higher than those of the "B" series, and from these, together with the evidence of the chilled and unchilled bars made from low grade iron, we are of the opinion that with ordinary commercial pig irons, no matter what their chemical compositions may be, there is a rate of cooling which will give high physical properties, the structure of the iron then being associated with the net-like formation of the phosphorus eutectic and the cementite, when present.

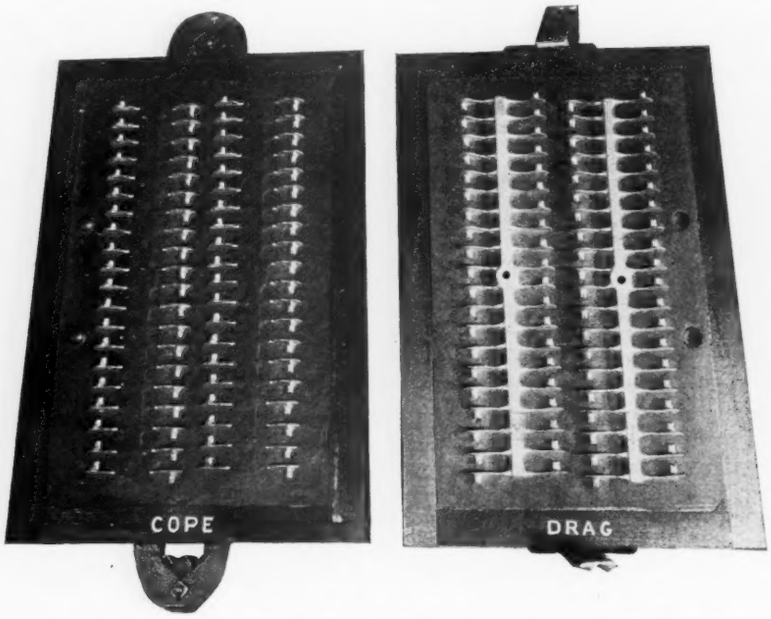


FIG. 1—COPE AND DRAG MATCH-PLATES FOR CASTING *H*, FIG. 3

Composition Match-Plates

A SET of composition match-plates containing the patterns for the two halves of a gray iron lock are shown in Figs. 1 and 5. The lock is illustrated in Fig. 4, and the two castings in Fig. 3. This lock is used for sealing freight cars, water and gas meters, and is self-locking, this being accomplished automatically by a small spring adjustment in casting *K*. The hook passes over a shoulder on casting *H*, and when locked rests against this section and the lock can only be removed by breaking off the hook. The lock complete, weighs less than one ounce, and each of the gray iron castings only a fraction of an ounce. Casting *K*, Fig. 3, is 1⅜ inches long and *H* is 1½ inches long.

The necessity for producing these castings as cheaply as possible is apparent, yet owing to their peculiar design many molding difficulties were encountered. As originally used, the patterns were gated and set loose in sand matches, but it was found almost impossible to obtain good results owing to the warping of the match-plates.

It was finally decided to have the patterns mounted on composition

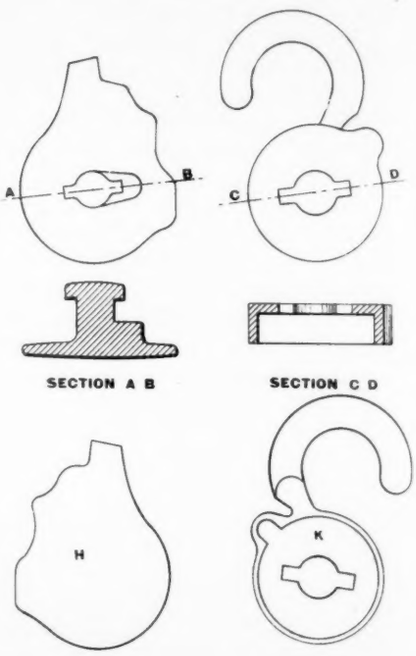


FIG. 3—VIEWS OF THE TWO SMALL CASTINGS COMPOSING THE LOCK

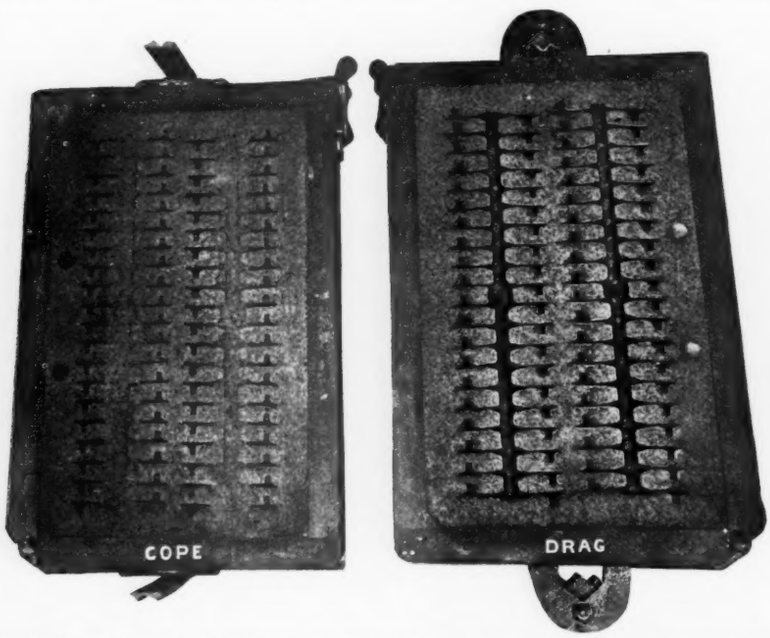


FIG. 2—COPE AND DRAG HALVES OF THE MOLD MADE FROM MATCH-PLATES, FIG. 1

match-plates and these were made by the Bayer Pattern Plate & Mfg. Co., Poe avenue and West Twenty-fifth street, Cleveland. To obviate the use of the original patterns, white metal patterns were made of both castings, only a fraction of an ounce, Fig. 3, were first mounted, and owing to the difficulties experienced in obtaining an accurate parting, it was decided to cut the white metal patterns from the gates for the cope half of the match-plate and these were inlaid in the composition as shown at the left, Fig. 1. Fig. 2 is the drag half of this plate with the white metal patterns embedded in the composition. This method of mounting the

patterns was decided upon in view of the many sharp edges which might be more easily broken off if the patterns had been reproduced in the composition.

It will be noted that 40 castings are attached to each runner, making a total of 80 to the mold. The cope and drag halves of the mold made from these plates are shown in Fig. 2. The match-plates were made so accurately that the molds required no finishing and the castings, after tumbling, were ready for assembling. The molds were made with no more than ordinary care and the sharp edges reflect the excellence of the match-plate work.

The patterns for the other casting, *K*, Fig. 3, were mounted on the

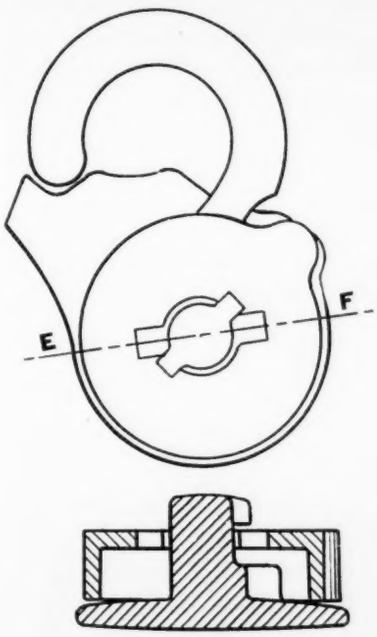


FIG. 4—PLAN AND SECTIONAL VIEWS OF THE ASSEMBLED LOCK

match-plate shown in Fig. 5. The drag plate is made entirely of the composition, while the white metal patterns are embedded in the composition in the cope half of the plate. To each runner were attached 28 patterns, making a total of 56 castings in each mold. The drag and cope halves of the mold made from these plates are shown in Fig. 6. These molds likewise required no finishing and these castings, after cleaning, were easily assembled with the castings made in the mold, Fig. 2, which constitute the other half of the lock.

THE INSTITUTE OF METALS.

The council of the Institute of Metals has inaugurated an annual series of May lectures, the first of which will be held in London, Eng., Tuesday, May 24, when Prof. Gowland, vice president of the Institute, will deliver an illustrated lecture on "The Art of Working Metals in Japan." Previous to the lecture, there will be a meeting of the Institute when new members will be balloted for. Applications for membership should be addressed to the secretary, G. Shaw Scott, Caxton House, Westminster, S. W., London, Eng.

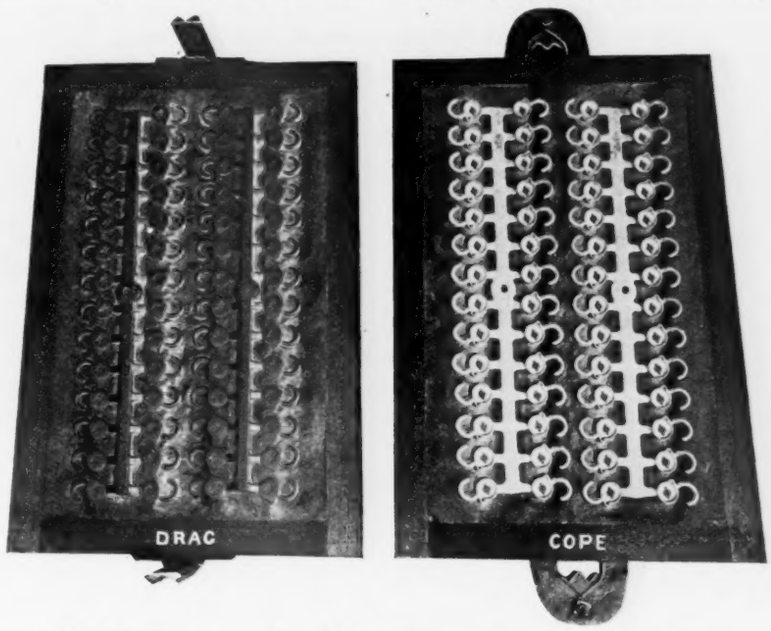


FIG. 5—DRAG AND COPE MATCH-PLATES FOR CASTING *K*, FIG. 3

THE WORSHIPFUL COMPANY OF FOUNDERS' EXHIBITION.

The competitive exhibition promoted by the Worshipful Company of Founders of London, Eng., promises to be of exceptional interest to the foundry trade and will be held this year at Ironmongers' Hall, June 7 and 8. The exhibition will comprise castings in aluminum, bronze, brass, gold, iron and silver, and designs in plaster, wood or any other material which may be cast or cut. Various awards will be made and the highest prize of $100 is offered for the best model of a medal for the Worshipful Company of Founders. Other prizes will be given for the best statuary castings, groups, figures or heads and for ornamental panels, cast railing designs, bells, and the best design, model or pattern for any kind of cast metal work. The competition is open to designers, patternmakers and molders, whether apprentices or journeymen. They must be British born, residing in England. The prizes of the first class, range in value from $25 to $70 each, and in the second class from $12 to $37 each.

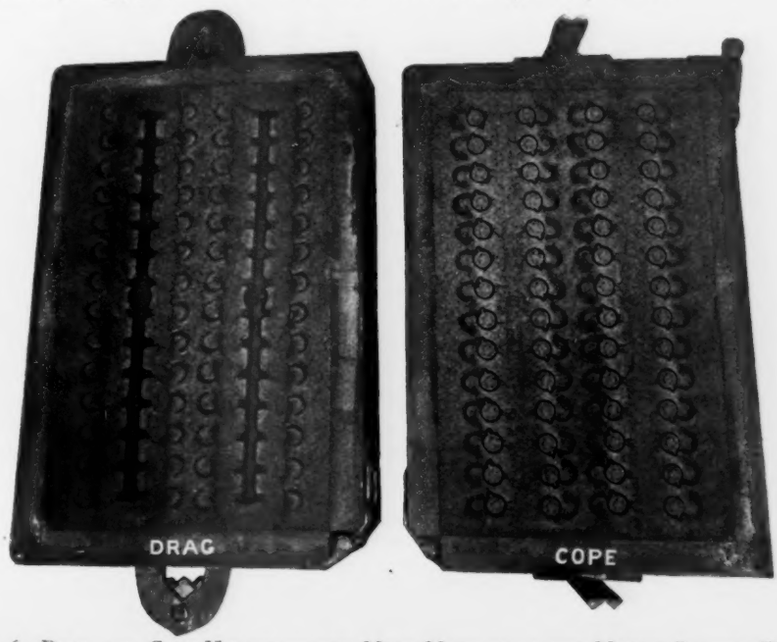


FIG. 6—DRAG AND COPE HALVES OF THE MOLD MADE FROM THE MATCH-PLATES, FIG. 5

LATTER-DAY STEEL FOUNDRY PRACTICE*

A discussion of the crucible, open-hearth, side blow converter and electric processes of producing steel castings

BY PERCY LONGMUIR

IN A paper read before this association in 1899, Mr. Fletcher dealt with some characteristic features of steel castings. In that paper two vital points were emphasized — the shrinkage of steel and the importance of design in meeting this shrinkage. Carried to a logical conclusion, attention to these two points will result in the production of a casting free from defect due to the unequal distribution of metal. In the present paper the author proposes to take a survey of steel foundry practice, touching generally on the processes followed and alluding to some of the difficulties met in the conduct of these processes. Steel castings are the product of (1) Crucible furnaces; (2) the open-hearth furnace; (3) the Bessemer converter and its modifications; (4) the electric furnace. Steel castings are not produced from cupola metal and malleable annealing ovens. Enthusiasts sometimes foretell the replacement of gray iron and malleable castings by those of steel, but considerable advances are necessary before this occurs. Gray iron, malleable iron and steel respectively fill fields of usefulness which do not admit of ready replacement.

Steel is not a term admitting of ready definition, but for the sake of simplicity may be regarded as iron associated with a certain amount of carbon. As this description covers cast iron and malleable cast iron, it may be well to take, as a starting point, a few typical mechanical properties.

These results, Table I, are selected from a series of tests by the author†. With the exception of the first, they represent commercial metals cast in sand molds, the pure iron and the steels are annealed and the white iron and gray iron are in the cast condition. The iron and steel members of this group possess more or less ductility, the white iron and the gray iron will neither stretch nor bend, while the annealed white iron occupies an intermediate position. Hardness is to some extent a function of the amount of combined carbon, hence the steel casting containing 0.51 per cent combined carbon and giving an elongation of 22.5 per cent when under the tool, possesses a similar hardness to the gray irons.

The Preparation of the Mold.

The fundamental principles of molding do not vary for cast iron, brass or steel. While principles are common, details necessarily vary to suit the particular grade of metal entering the mold. A consideration of general principles can be omitted, but a few words are necessary as to modifications imposed on the mold when the fluid entering it is molten steel. When compared with gray iron, steel has a distinctly higher initial heat, a very narrow range of fluidity and a greater contraction co-efficient; these features are responsible for the difference in detail between cast iron and steel foundry practice.

The high initial temperature of steel demands a very refractory facing for the mold, one high in silica. The greater portion of steel molding represents dry sand work, the molds being dried before pouring. When a natural sand is used a grade high in silica is selected, and any deficiency in bond is supplied by clay admixture. Many of the facings represent made-up compositions, and, as a rule, these consist of burnt refractory material ground to the required fineness and mixed with various building agents. High initial temperature is therefore met by increased refractoriness in the mold. The narrow range of fluidity is met by suitable adjustment of gates in order that the mold shall fill quickly and the resulting casting be sharp and true to pattern. This, however, is only one aspect of the limited range of fluidity and a greater one lies in its effect on liquid shrinkage.

Shrinkage and contraction are terms often used with loose freedom. "Technically, shrinkage refers to the gradual lessening in volume of fluid metal as it approaches the solidification point at which shrinkage ceases and contraction commences, contraction being understood to refer to the lessening in length or in volume of the solid metal."†

Table I.

ANALYSES AND MECHANICAL PROPERTIES OF IRON-CARBON ALLOYS.

Material.	Combined carbon, per cent.	Graphite, per cent.	Silicon, per cent.	Manganese, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Maximum strength in tons, per sq. in.	Elongation, per cent in 2 inches.	Reduction of area, per cent.
Pure commercial iron..	0.08	...	0.04	0.06	0.03	0.01	18.5	35.0	52.2
Steel	0.28	...	0.15	0.29	0.06	0.05	28.0	33.5	45.6
Steel	0.29	...	0.07	0.16	0.07	0.06	27.2	24.0	32.3
Steel	0.36	...	0.22	0.89	0.02	0.02	29.2	18.5	18.0
Steel	0.51	...	0.11	0.42	0.06	0.05	35.4	22.5	27.0
White iron	3.40	...	0.39	0.05	0.02	0.02	12.1	....	....
White annealed	0.20	3.2	0.39	0.05	0.02	0.02	29.2	3.5	....
Gray iron	0.52	3.4	1.78	0.28	0.04	0.27	14.1	....	....
Gray iron	0.50	3.2	1.75	0.50	0.05	1.20	12.0	....	....

Guarding Against Shrinkage.

Liquid shrinkage cannot readily be measured, but this shrinkage must be met if a solid casting is desired. Gray iron having a comparatively long interval of fluidity, liquid shrinkage may be met by means of normal feeding heads. These heads are artificially kept open by the aid of a feeding rod, and thereby offer a means of supplying the natural shrinkage of the solidifying casting. The narrow range of fluidity familiar to steel practically precludes the use of feeding rods. Shrinkage must therefore be met entirely from the feeding heads. This fact necessitates the use of much

*Read before the Manchester, Eng., Association of Engineers.

†"General Foundry Practice," McWilliam and Longmuir.

heavier feeders than would be employed on the same casting if made in gray iron. Whether one or more heads are employed is determined entirely by the contour of the casting. In plain, bulky work one central feeder may be effective, but in other cases it may be necessary to split the one feeder into several units, each having a local effect. The feature of moment is that the shrinkage of steel is high and quick in action; the measures adopted must therefore be such as will promptly supply the demands of the rapidly shrinking fluid. In many cases this will necessitate feeding heads of a volume equal to a third of that of the casting produced.

The period of liquid shrinkage is followed by solid contraction and this phase introduces some little details demanding special provision. Under normal conditions, steel castings will give a contraction of 3/16-inch per foot of length, thus a steel liner 20 feet long will give a total contraction of 3¾ inches. If the liner is provided with end flanges, then each flange must travel towards the center a distance of 1⅞ inches, and if the character of the mold will not permit this movement, then fracture will occur or inherent weakness be developed. The art of the steel molder is, therefore, shown in his efforts to meet this contraction. In many cases light molds are essential in order to resist fluid pressure, and the well-known resources of the iron molder—yielding coke beds and the like—are not always applicable.

In such cases the mold must be eased, when the casting has just solidified, by loosening the unyielding parts, thereby giving freedom for the contracting casting to move. Castings of intricate form are strengthened on the lighter parts by means of ribs or fins which are cut off in the dressing shop. In other cases wrought iron rods are embedded in the center of the lighter parts in order to secure the same end. Large intricate castings, when of light section, are most successfully dealt with by casting in a green sand mold, skin dried and dusted with suitable facing.

The Production of Steel.

Of the various steel-making processes, that known as the crucible is characterized by the absence of strong chemical reactions. High quality in the case of crucible steel, is dependent on initial purity in the materials entering the mixture. Therefore, the process may be described as one of mixing and melting, and skill in its conduct depends on the selection of raw material and adjustment of the charges followed by careful melting practice. The method is famed for high quality, but so far as castings are concerned is only used to a limited extent, and then chiefly for special qualities. It is worth noting that in America, crucible castings represent an expanding industry.

Bessemer Steel.—The majority of castings produced from Bessemer metal represent modifications of the original process, and the converters employed are generally of the surface or side-blow type. Whatever the type of converter employed, the underlying principle is that of purification by the oxidation of certain impurities. The initial product is molten pig iron from an iron-melting cupola. This metal is blown in order to oxidize carbon, silicon and manganese; thus, if sulphur and phosphorus are initially low a comparatively pure product ensues. The changes in the conversion of molten cast iron into steel are shown in Table II.

Table II.

	Cupola metal, per cent.	After 5 minutes blowing, per cent.	After 12 minutes blowing, per cent.	After 14 minutes blowing, per cent.	After 18 minutes blowing, per cent.	End of blow, per cent.	Finished metal, per cent.
Graphite	3.180	2.920	.....	.....	.....	.....	.....
Combined carbon	0.350	0.340	2.900	2.300	0.860	0.100	0.240
Silicon	2.310	1.620	0.466	0.382	0.084	0.074	0.326
Sulphur	0.037	0.037	0.035	0.036	0.038	0.038	0.037
Phosphorus	0.054	0.053	0.054	0.054	0.051	0.050	0.058
Manganese	0.610	0.600	0.101	0.040	0.040	0.042	1.080

Open-hearth Steel.—As with the Bessemer, the open-hearth process is based on the oxidation of the impurities in pig iron. In this case, the necessary oxygen is added in the form of iron ore to a bath of molten metal. The surface of this metal is covered by a layer of slag, which shields the metal and also plays a decisive part in the purification of the underlying metal.

Table III.

	Carbon, per cent.	Silicon, per cent.	Manganese, per cent.	Sulphur, per cent.	Phosphorus, per cent.
Analysis of charge	2.90	1.90	0.60	0.04	0.05
Melted metal—3 hours after charging	2.50	1.10	0.25	0.04	0.05
1 hour after melting	1.87	0.30	None	0.04	0.05
2 hours after melting	1.48	0.10	None	0.04	0.06
3 hours after melting	0.81	0.05	None	0.05	0.06
4 hours after melting	0.56	0.04	None	0.05	0.06
5 hours after melting	0.39	0.03	None	0.05	0.06
6 hours after melting	0.13	0.01	None	0.06	0.06
Finished steel	0.20	0.02	0.56	0.06	0.06

In acid open-hearth practice, purification is limited to the removal of carbon, silicon and manganese. Details of an ordinary heat are given in Table III.

The figures in this table give a good illustration of the stages of purification. Sulphur and phosphorus are not removed, and as a rule come out slightly higher than in the initial charge. In the basic open-hearth process sulphur and phosphorus are removed, hence phosphorus irons are admissible.

Electro-Thermic Processes.—Electric furnaces are attracting considerable attention, and deservedly so. Practically speaking, electro-thermic methods represent basic practice, and very successful results have been obtained in the production of low sulphur and low phosphorus steels from material impure in these respects. In several instances electric furnaces have proved successful in foundry practice, but they have not yet entered into serious competition with established processes.

Comparison of Processes.

The crucible process gives high-grade castings, has a limited capacity and high cost of production. Heavy castings are almost impossible, and further, it is difficult to produce dead mild steel by this process. The narrow range in the fluidity of steel has been referred to; this range lessens as the content of carbon falls, and it is difficult to attain the necessary heat in crucible practice to melt a steel of lower carbon content than 0.5 per cent. The crucible process serves a most useful purpose in the direction of special qualities when required in small quantities. Its real limitations are cost and lack of fluidity in dead mild steels.

The ideal process for heavy castings lies with the open-hearth plant, which

may be operated either by the acid or basic method, as desired. It is true that basic castings have not yet developed to a great extent, but the future is promising. The plant is costly and necessitates continuous operation if successful working is desired. Furnaces vary in capacity from two tons upwards, and any type of steel, from the softest to the hardest, can be produced. Under current practice the furnace, when tapped, must be completely emptied. With bulky castings this feature is an advantage, but with light work it necessitates large floor area over which the metal must be distributed. The time occupied by this distribution is apt to lead to chilling, and a consequent danger of mis-run castings towards the end of the casting operation.

The surface-blown converter eliminates the last feature in that the steel is obtained in comparatively small quantities at regular intervals. The steel at the end of the blow is exceedingly hot and fluid; these features, supplemented by small weight, allow of a rapid distribution over the casting floors, and therefore minimize the danger of mis-run castings in the case of light section. The process is fairly elastic, may be readily started or stopped without serious outlay, and will produce steels of any desired composition. Its special field lies with light and medium weight castings, and good results are being obtained in this direction.

Electro-thermic processes have hardly entered the commercial stage, but so far as foundry practice is concerned the advantages lie in the high temperature, giving fluidity and, therefore, special applicability to light work. In this direction these processes will have to compete with surface-blown converters.

Sound Steel Castings.

Soundness is admittedly one of the most desirable features in a steel casting, but in addition to solidity the casting must yield certain mechanical properties, therefore the term "sound" may, in this section, be regarded from a wider point of view than the absence of blow-holes.

The shrinkage of steel has been referred to, and the obvious remedy lies in feeding the shrinkage with the requisite supplies of molten steel. Defects due to this cause are usually self-evident, and the casting itself should suggest the remedy. A clear distinction should be drawn between the defects due to shrinkage, and those due to unsoundness. In the former case the evidence is shown in pipe, drawn holes, etc., and in the latter case by the presence of blow-holes or sponginess.

Contraction has also been referred to, but it does not follow that castings will always show the legitimate 3/16 inch per foot. In some cases a casting may come out to the pattern size showing no contraction. This may be due to two causes: (1) the presence of excessive blow-holes, or (2) the design may be such as to retard movement when cooling, thereby developing stresses within the casting.

A blown casting does not, as a rule, feed well, and the steel, instead of settling quietly in the mold, tends to rise and froth through the feeding heads. Such metal is generally known as wild or fiery. A steel which settles quietly, feeds at a normal rate, and gives the usual contraction, is described as thoroughly dead melted or killed.

Table IV.

No.	Analysis. Carbon, per cent.	Silicon, per cent.	Manganese, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Maximum stress, tons per per sq. in.	Elongation, per cent on 2 inches.	Reduction of area per cent.
80 A	0.29	0.07	0.16	0.07	0.06	24.2	9.5	18.0
81 A	0.29	0.07	0.16	0.07	0.06	27.2	24.0	32.3
82 A	0.29	0.07	0.16	0.07	0.06	27.0	12.5	17.5
83 A	0.29	0.07	0.16	0.07	0.06	25.5	8.0	12.0

General Operations.

In the brief review of steel-making processes it will be noted that the crucible method involves the least chemical change. So far as ordinary steel-making is concerned, chemical change means the oxidation of impurities in pig iron and, therefore, strongly oxidizing conditions must prevail. In the crucible furnace oxidizing conditions are at a minimum, and, in fact, the atmosphere is often reducing. In the absence of other features this tends to the production of steel free from dissolved oxide and blow-holes. An over-oxidized steel does not necessarily imply a steel containing blow-holes, but the fact remains that the two are often associated, and the removal of excess oxygen will also tend to freedom from blow-holes. Given a high temperature coke-melting furnace, pure iron can be melted, and by aid of a trace of aluminum only, be poured into sand molds. The castings are sound, and, after annealing, tough and ductile. The first result in Table I represents a casting produced under these conditions.

Absorption of Gases.

In the Bessemer and open-hearth processes the steel is not shielded, as in the crucible. When opportunity affords molten steel readly occludes gases, hence, under strongly oxidizing conditions it follows that oxygen will enter the steel. The affinity of iron and oxygen is such that the oxide formed remains stable at low temperatures. In the absence of any deoxidizing additions, the oxide formed at high temperatures remains dissolved in the steel at low temperatures. In a casting the effect would be low elongation and an absence of ductility. The steel would be generally described as dry, and would also most probably be riddled with blow-holes. The surface of these blow-holes is usually free from oxidation tints, and further, the actual gas, when examined, is not found to contain free oxygen. As a rule, the gases chiefly present are hydrogen and nitrogen.

The actual volume of gases absorbed by molten steel depends to some extent on the temperature and composition of the bath. While the steel is fluid, the gases are retained, but after casting and with falling temperature they are evolved to some extent. Gases set free by falling temperature bubble through the fluid mass, but are more or less trapped when the fluid becomes a pasty solid. As the temperatures continue to fall, less movement is offered, and the gases, unable to pass through the metal, form bubbles at or near the point of evolution; when the casting sets or becomes rigid, the formation of blow-holes becomes impossible. Obviously, liquid compression should have a beneficial effect in retarding the evolution of gases, but advantage cannot be taken of methods of compression so far as ordinary castings are concerned. The usual method of prevention is by addition to the steel, and the more familiar additions are metallic aluminum, ferro-manganese and ferro-silicon. In shop parlance these elements are described as cleansing agents, and they may be supplemented by sodium, vanadium, titanium and others.

Aluminum Increases Shrinkage.

Judging by results the joint or individual presence of aluminum, silicon, or manganese, tends to remove oxygen existing as oxide, and to increase the

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Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

FORMULAS FOR THE BRASS FOUNDRYMAN.

Cheap Red Metal.

This mixture has a wide range of usefulness for red brass castings when high tensile strength and elongation are not necessary. The metal is suitable for plumbers' goods, small bushings, valves and cocks, gas meter parts, or any red metal castings that are to be rapidly finished on turret lathes. The mixture is as follows:

	Per cent.
Copper	83.84
Lead	8.33
Zinc	8.33

Or,	Pounds.
Copper	20
Lead	2
Zinc	2

This mixture is easy to make. The copper is melted first, and, when charged, a small quantity of common salt is also placed in the crucible. When melting begins, charcoal is added to form a cover to protect the metal from oxidation. When the copper has melted, the zinc, which has been allowed to become hot by lying on top of the furnace, is dropped in with the tongs. The mixture is then stirred, the lead added, and the stirring vigorously repeated. When ready to pour, the surface of the metal should be clean and liquid under its cover of charcoal. The castings run smooth, with a nice bronze color, and the metal should be poured hot, although it is not necessary for it to boil.

FORMULAS FOR THE BRASS FOUNDRYMAN.

Common Casting Copper.

A very useful alloy for soldering irons, copper hammers and all copper castings where high conductivity is not essential, follows:

	Pounds.
Copper	96
Zinc	4

This formula will always be found satisfactory, as the zinc is sufficiently high to insure solidity, whether ingot or scrap copper is used. The color of the metal is sufficiently red to pass for copper, and the castings can be relied upon to show up clean, bright, sound and free from abnormal shrinkage.

The copper should be melted in a clean crucible, and, when first charged, two tablespoonfuls of salt are added. The chlorine gas from this protects the copper from excessive oxidation until it settles down in a liquid state, when it should be covered with charcoal, hard wood chips, tan bark, or any organic substance that forms charcoal. The zinc should be added after the copper is melted. The mixture is then thoroughly stirred and the metal is allowed to superheat a few minutes before being cast. If the color of the metal is not sufficiently red, the zinc, with careful melting, may be reduced to 2 per cent.

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solvent power of the steel for gases other than oxygen. In the presence of these elements the gases, therefore, remain dissolved in the steel, and no evolution occurring during solidification, no blow-holes are formed. The activity of these elements has been specially investigated by Brinnell, and he expresses the effect of aluminum as equal to 90 times that of manganese, and 17.3 times that of silicon. This relation, determined from a study of ingots, is found to hold in the case of castings, but experience favors the greater use of manganese and silicon rather than aluminum.

The last element has a tendency to increase liquid shrinkage, giving more pipe and leading to feeding troubles. Suitable additions applicable all round cannot be stated, for so much depends on the conduct of the heat. Experience is the best guide, but the object aimed for should be a well-killed steel, and given this there will be no trouble due to blow-holes, if the steel is poured into suitable molds. It may be well to note here, that an occasional blow-hole, provided it does not appear on joints or working faces, is not necessarily a disadvantage.

Annealing.

It is sometimes stated that good mild-steel castings can be produced without annealing, but such statements are only true in a limited sense, for much depends on the contour of the casting and also on the particular purpose to which it will be put. The primary object of annealing lies in the elimination of internal stresses, hence the importance of considering the contour of the casting and what it has undergone in contracting from a high temperature. This object is achieved by heating to, and maintaining at, a temperature of about 950 degrees Cent. for three days, followed by slow cooling. A casting demands very different annealing from that accorded to a forged steel, and the foregoing time and temperature are given solely in view of relieving internal stresses. The second object of annealing lies in breaking up the coarse cast structure, and thereby dovetailing the crystals one into another.

The feature is best shown by metallographic examination before and after annealing. The sharp boundaries in the first case are broken down in the second one, and the inter-crystalline junctions are strengthened by the interlocking of the ferrite and pearlite areas. Another feature of moment lies in the fact that any dangerous sulphide of iron films present in the casting become balled up by the long annealing, and in this form are comparatively harmless.

From the foregoing it is obvious that many variables may arise in the operations followed which have a powerful effect on the final result. Generally speaking, in standard practice the variable factor offering least control lies in the temperature of the metal as poured. Casting temperature is generally viewed from the point of soundness, and too high or too low a heat will lead to the presence of blow-holes, cold shuts, etc. This feature is the least evil, and the author's researches led to the conclusion that the effect of varying casting temperature should be considered from the point of mechanical properties. If a series of castings are poured from one ladle, commencing with an exceptionally high temperature and finishing with the lowest at which the metal will flow, the mechanical properties of the series will be found to rise until a fair casting heat is reached, and then fall with each successive fall in temperature. These varying properties, obtained from steels poured from one ladle within a few minutes of each other, are not restored to one level by subsequent treatment. The tests shown in Table IV represent steels poured from one ladle at intervals of a few minutes; they are of identical analysis, and were annealed together.

Results.

The elongations and reductions of area shown in Table IV are worth examination. Generally speaking, steel castings are low in carbon, and, therefore, possess a high melting point. As a result the danger will be to err on the low rather than on the high side. This has been examined by taking the crucible steel which had not been overheated, and pouring sets of castings at the fair and a low heat. The results are given in Table V.

Here it will be noted that the tensile results show no variation. Differences in bending led to alternating tests being made, with the results shown. The low heat, even after annealing, is not brought up to the level of the fair heat in its cast condition. A similar steel cast under the same conditions into two ingots and forged into 1-inch round bars gives the results shown. These results are included by way of showing the survival of the influence of varying temperatures when the steels have been submitted to identical forging treatment. Here again tensile tests do not discriminate between ductile and brittle material.

Incidentally, the forged results show the beneficial influence of work on steel and offer a good illustration of the difference between forged and cast steels of like analysis.

Table V.

No.	Analyses. Carbon.	Silicon.	Manganese.	Sulphur.	Phosphorus.	Casting Temp.	Condition.	Tensile tests. Maximum stress, tons per sq. in.	Elonga'n per cent on 2 in.	Alternat'n of test. Reversals to complete fracture.
97	0.36	0.22	0.89	0.02	0.02	Fair	As cast	35.8	12.5	68
98	0.36	0.22	0.89	0.02	0.02	Low	As cast	34.2	11.5	48
97 A	0.36	0.22	0.89	0.02	0.02	Fair	Annealed	27.0	17.5	122
98 A	0.36	0.22	0.89	0.02	0.02	Low	Annealed	28.2	18.5	62
99	0.37	0.18	0.87	0.03	0.02	Fair	Forged	40.9	27.5	546
100	0.37	0.18	0.87	0.03	0.02	Low	Forged	40.1	28.0	172

USE OF SCALE IN STEEL CASTING PRODUCTION.

The use of briquetted hammer scale, or other suitable substance containing ferric oxide, mixed with slacked lime in the Bessemer and open-hearth processes of steelmaking is the subject of a patent recently granted J. Flohr, a foreign steel works manager. The scale is briquetted with the lime as a binder and in the basic Bessemer process, the addition to the charge is made after decarburization. It is important that the briquettes are made sufficiently heavy to penetrate the slag. They are introduced into the converter by hand when the slag is sufficiently liquid to permit them to pass through it. The advantages claimed include a shorter blowing period, while the life of the converter lining and bottom is increased. This process can also be used to advantage in open-hearth furnaces.

ALUMINUM GAS ENGINE CYLINDERS.

Applications for patents on the production of aluminum gas engine cylinders, described in the April, 1910, issue of THE FOUNDRY, have been made by F. C. Ewen, president of the General Machinery Co., Bay City, Mich., in the United States and all foreign countries.

CRUCIBLE STEEL CASTING PROCESS — I

Design and construction of various types of furnaces for melting crucible steel — Crucible tongs and the life of pots

BY CARL SMERLING

CRUCIBLE steel is generally supposed to be of superior quality to open-hearth steel. This is largely due to the metal being protected by the covered crucible from the oxidizing effects of the flame. It is necessary, if the high standard of crucible steel is to be maintained, for the crucible to be kept closely covered while in the furnace, otherwise the metal will be no better, if as good, as open-hearth steel of like composition. This is due to the fact that there is the same relative exposure of metal surface to the flame in both cases, with possibly a slight advantage in favor of the open-hearth. In both cases the metal is subjected to the flame and absorbs sulphur, hydrogen and nitrogen, with deleterious results. From 20 to 30 per cent of the crucible steel is melted today without covers, and it makes no difference whether the flame is directed onto the crucible or onto the metal. The result is the same as regards its superiority over open-hearth steel. Therefore, if crucible steel is used because of its better quality, the greatest care must be exercised in melting to protect the metal from the flame. Apart from any question of superiority, crucible steel possesses a field of its own in doing local work, for repairing machinery, the making of tool steel and small castings for automobiles.

Fig. 1 shows one of the first crucible steel melting furnaces introduced in this country. The first chamber was used for melting, the second, though intended for melting, was found available only for preheating, and the third compartment was never used except for examining the flame. Oil is supplied through pipes, *l*, from an overhead tank, and cold air for combustion enters at spaces between pans at *c* and through the air slot at *h*. The direction of the flame is shown by dotted line starting from the pans, to stack, *d*. The damper, *e*, regulates the draft, while the iron plate is provided to regulate the air supply. To facilitate cleaning, the flues, pit, *J*, is provided, but it is more commonly built higher and covered with an iron plate at the floor level.

Construction of the Furnace.

It was intended, that when pulling pots, the flame should be drawn through the flue, *g*, when the damper, *f*, is open, and *e* closed. This flue, however, is not commonly used. A layer of crushed coke and old crucibles is placed at the bottom of the furnace and the latter so arranged that when a pot breaks a bar is driven through at *O* and the metal allowed to run into the flue below, but it is difficult to remove this mass of steel and slag without tearing the furnace to pieces. The melting holes are covered with an iron-bound fire brick slab, with peep holes over each crucible, so the condition of the metal can be noted without removing the covers.

The average run of such a furnace is 16 days, after which the side walls and arches must be replaced, temporary repairs being made weekly. This furnace, as used at the present time, has an average day's run of seven heats of two pots each, consuming 170 gallons of oil.

Present Milwaukee Type of Furnace.

This type of furnace was introduced into Milwaukee crucible steel foundries 21 years ago. Fig. 2 shows the furnace at present in general use. It will be seen that the melting chamber is in one compartment, and its only resemblance to the furnace previously described is in the pans and air inlet. Cold air is also used in this furnace, entering at spaces between pans, and through the air slot *d*, following the dotted line to stack.

Construction of Milwaukee Furnace.

This furnace is more simple than the other, the bottom flue, bridges and damper being eliminated, the oil supply, air regulation and bottom being the same. The capacity of the furnace ranges from six to eight pots, the latter size turning out six heats per day, of four pots each, with a fuel consumption of 240 gallons of oil. The maximum life of the furnace is two weeks, when the side walls and arches must be rebuilt. A second quality refractory brick is generally used, as the irregularity of furnace operation, only 12 or 15 hours per day, causes the brick to spall or

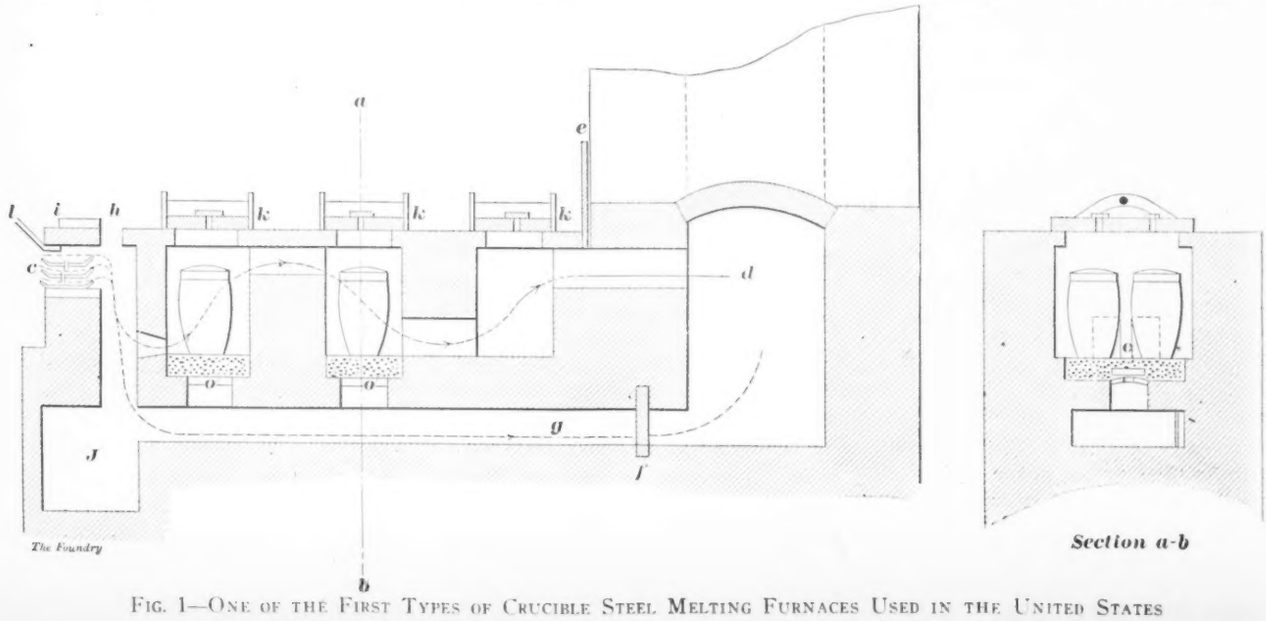


FIG. 1—ONE OF THE FIRST TYPES OF CRUCIBLE STEEL MELTING FURNACES USED IN THE UNITED STATES

chip off. If the furnace could be run continuously, a higher grade brick could be used in the lining, which would increase the life and consequently lessen the cost of production.

Trouble is occasionally experienced with the bottom, the crushed coke and crucible sticking to the pot when pulled out hot. This is particularly the case with a new bottom and can be remedied by placing pieces of broken crucible on top of the crushed coke and on these crucible dust is sprinkled.

The fuel used in these furnaces is a light refuse oil from the refineries, and costs from 4 to 6 cents per gallon. Several attempts have been made to reduce this cost by using a heavy refuse oil, costing from 2½ to 3 cents a gallon, but this has so far failed, as the flame was not good and the oil carburized in the pans, necessitating extra labor in keeping them clean, and entailing a loss of from 20 to 30 per cent in fuel. In both types there is considerable waste of fuel, but more so in the first, as in some cases perfect combustion does not take place before the flame reaches the stack.

Fuel Consumption Compared.

The following figures furnish a comparison in fuel consumption: First type furnace, Fig. 1, 14 pots per day, averaging 86 pounds each; consumes 170 gallons of oil, which equals 282 gallons per ton of steel melted. In the second type, Fig. 2, the output is 24 pots per day, of 85 pounds each, consuming 240 gallons of oil, which is 232 gallons of oil per ton of steel melted. These figures are fairly reliable, but of course do not apply to all furnaces, as a great deal depends on the skill and knowledge of the operator.

Operation.

The furnaces are started at 3 a. m. by lighting the pans, the crucibles having been placed in readiness the evening before, and the first four pots are usually ready at 6:30 a. m., when the mixture is added by means of an iron pipe inserted through the hole in the cover. The pots are then "pulled," the remaining ones moved forward, and newly filled crucibles are placed in their stead. Killing is omitted, and after the pot is skimmed, a small piece of aluminum is added, which takes the place of the killing formerly practiced, and which consisted of superheating the metal for a few minutes after the mixture was added.

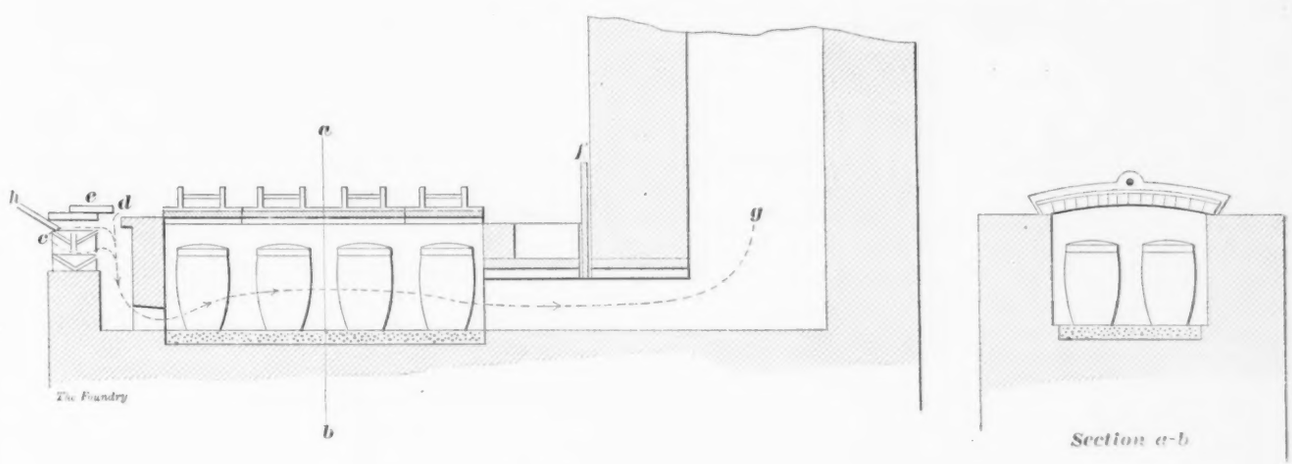


FIG. 2—THE MILWAUKEE TYPE OF CRUCIBLE STEEL MELTING FURNACE

Pulling the Crucibles.

The pot having been pulled, it is placed in the shank, which is raised from the floor by two stools. A little dry floor sand is now thrown onto the metal to thicken the slag, after which it is removed by a flat skimmer. The pots are now generally pulled by a hand lever which is connected to the tongs by a pair of chains, the lever being suspended by an overhead trolley. The melter secures the tongs on the pot while a helper lifts the crucible with the lever. A block and tackle was formerly used in the west, but in my opinion is not so convenient as the lever. Another lever is also used for removing the furnace covers, as shown in Fig. 3.

Crucible Tongs.

One of the best types of tongs is shown in Fig. 4. They should be carefully fitted to the crucible, the distance between the handles where the chain is attached being not too great, otherwise there will be too much strain on the pot. If they are fitted correctly the crucible may be pulled out with as much safety as if done by hand.

The shank used for teeming the metal is shown in Fig. 5. A man

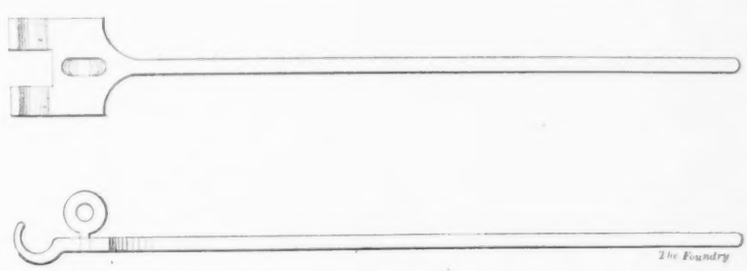


FIG. 3—LEVER USED REMOVING FURNACE COVERS

with a hooked rod prevents the pot from tipping out of the shank and another skims the metal with a flat hooked iron and prevents the slag from entering the mold, but it is a frequent occurrence to find slag in crucible steel castings, and then their destination. is the scrap pile. This shank has been found to be more convenient than the one shown in Fig.

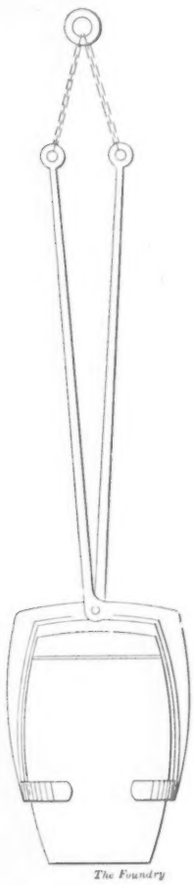


FIG. 4—CRUCIBLE TONGS, WHICH PROPERLY FIT THE POT

6, because the latter loses its shape, being warped by the heat, though with the one shown in Fig. 5, it is necessary to adhere to one standard size and shape of crucible, or to procure new shanks.

Life of Crucibles.

The crucibles generally average four and five heats, but in order to reach this record they must be daubed on the outside with a mixture of fire clay and powdered crucibles, moistened with water, using no more than sufficient clay to make the mixture adhere. This may be done by the use of a large trowel. Prior to this, however, the slag from previous heats must be scaled from the outside. This protects the crucible from the cutting action of the flame. It becomes necessary to decrease the charge after each heat because of the cutting action of the slag within the crucible, and the charges should commence with 95 pounds of cold metal and decrease five pounds after each heat.

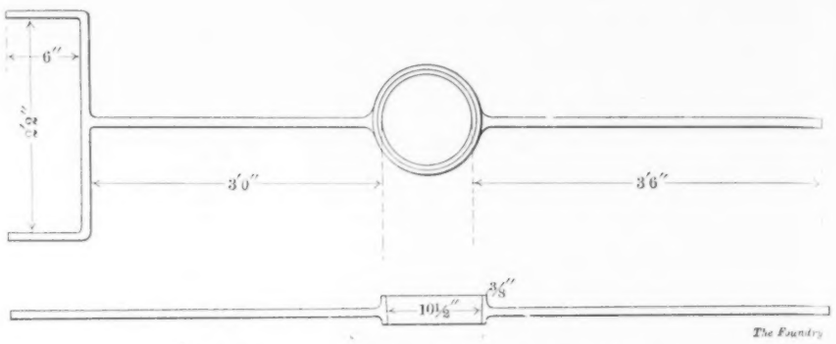


FIG. 5—SHANK USED FOR TEEMING THE METAL

BLOW-HOLES IN GRAY IRON GEAR BLANKS.

BY W. J. KEEP

Question:—We are experiencing considerable trouble with gear blanks, which crack, as shown in the accompanying illustration, and in addition, when machined, develop blow-holes in the rim and hub, as indicated. We use a tapered sprue, 2½ inches high and ¼ inch at the neck. The hub is cast solid, the metal entering the mold through this section. The blow-holes have the appearance of being caused by shot iron. We are using 60 per cent of No. 2 pig iron in one mixture, as well as 40 per cent of first class machinery scrap. Our fuel is high grade Connellsville coke and the iron is run hot.

Answer:—Shot iron is caused by drops of molten iron in the sprue before the full stream enters. The sprue should be increased in size so that the iron will fill the mold quickly. The drops of iron are instantly oxidized and will, in every instance, cause blow-holes around them. From the difficulties that you are experiencing, it is evident that the silicon of your mixture is rather low. By increasing the silicon, the tendency to blow-holes will be lessened. A small amount of pure aluminum dropped into the ladle before pouring will decrease blow-holes. The cracking of your castings will be prevented by an increase of silicon, and the use of 50 per cent ferro-silicon in your mixture will give you a soft, close-grained, strong iron.

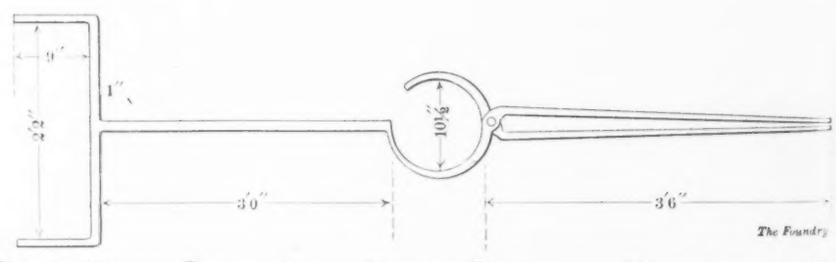
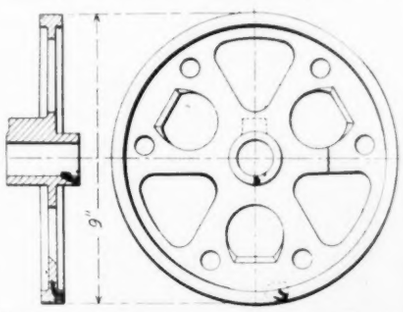


FIG. 6—ANOTHER TYPE OF SHANK USED FOR TEEMING THE METAL, BUT THE ONE IN FIG. 5 IS PREFERRED

Among recent shipments and installations of Newten cupolas by the Northern Engineering Works, Detroit, Mich., are the following: Cupola, 6-ton



PLAN AND SECTIONAL VIEW OF CASTING SHOWING BLOW-HOLES AND FRACTURE

hourly capacity, to the Franklin Foundry, Columbus, O.; one 10-ton cupola to Cuba; one 8-ton cupola to Holyoke Motor Foundry, Holyoke, Mass.; one 6-ton cupola to the American Well Works; one 5-ton cupola to Towers & Sullivan Co.; one 4-ton cupola to the Birmingham Car & Foundry Co., Birmingham, Ala.; one 6-ton cupola to J. B. Foote Co. and one cupola to Jackson & Church Co.

THE BRASS FOUNDRY

The Porosity of Brass Castings

BY C. VICKERS

THERE are few foundries that have not experienced trouble at some time or another with porous castings, and when we consider the number of deoxidizing agents and fluxes on the market, it appears to be an ever present difficulty. The castings shown in Figs. 1 and 3 are bronze glands, which were cast solid and afterwards bored. They weighed about 3 pounds each, and, as shown in the illustrations, exhibited a bad case of porosity, which, as usual, was not visible until the castings were machined, a peculiarity which makes castings defective from this cause doubly expensive, as there is no indication on the outside of the condition which exists within. The skin of the castings, which is smooth and perfect, can be seen on the hexagonal part of Fig. 3, also on the lower view of the piece of bushing in Fig. 2. It might be inferred from the size of the holes shown in Fig. 2, that they were caused by the core blowing, but all the weight of the evidence was against this, as the cores were standard stock cores, such as were being used every day in iron castings with good results. Therefore, it was clearly a case of oxidation, or to use a more common term "burnt metal."

FIG. 1—TOP AND BOTTOM VIEWS OF POROUS BRASS CASTING

Use of Deoxidizers.

The entire heat, of which these castings formed a part, was spongy. Some of the castings weighed over 80 pounds and were full of holes similar to those shown. It is well known that some metals absorb gases so easily when heated that they cannot be cast without the addition of some deoxidizing agent. This is the case with steel and nickel, while copper is a familiar example to the brass founder, who has discovered by experience that no matter how solid the copper may be before it is melted, if poured into the molds without treatment, they only remain full a short time before the copper rises in the sprues and overflows onto the floor. In every case the castings will be found honeycombed with holes whenever this occurs. For this reason it is necessary to alloy some other metal or element with the copper, which having a greater affinity than copper for oxygen, combines with the latter to form an oxide that either rises to the surface as a slag, or escapes into the atmosphere like smoke. The latter is the case when zinc is added to the molten copper, while phosphorus forms a slag which is so lively that it is ever changing form and position on the surface of the metal.

Burning the Metal.

When copper is melted under charcoal in general practice, with ordinary care, the amount of gases absorbed is comparatively small, and the metal, when cooled, possesses a metallic appearance, even though not solid; but if the heating were to be continued sufficiently long, the copper would, in time, lose the characteristics of a metal, passing into an oxide. An example of this change may be noted when insulated copper wire is burned off to remove the insulation. A scale forms on the wire, which is brittle and falls off in the form of dust, which is simply ashes of copper, and if the clean wire were again heated red and allowed to cool, more ashes would be formed, until all the copper is burned, or oxidized. The only difference between burning copper and burning wood is that oxygen forms gaseous products from wood, which escape

FIG. 2—SECTIONS OF BRASS BUSHING SHOWING EXTREME POROSITY

and are not recoverable, the wood being entirely destroyed. In the case of copper, solids are formed which are greater in volume than the original metal, and from which the oxygen can be separated, to recover the metal. Therefore, it will be noted that copper can be burned, like most other substances; that it is also easily burned at a low temperature, which explains why it is necessary to protect it from the atmosphere as much as possible while in the furnace.

Deoxidizing Agents.

As previously stated, no matter how carefully copper may be melted, sufficient gas is always absorbed to prevent its being cast pure; therefore, the copper must always be deoxidized, and the two substances generally used for this purpose, in making brass or bronze, are zinc and phosphorus. Tin is not an active deoxidizer, so while alloys of copper and tin can be made without the addition of any other element, they are so liable to porosity that it is always desirable to add either zinc or phosphorus. A familiar example of the use of zinc to prevent porosity is the well known alloy—copper 88 per cent, tin 10 per cent, zinc 2 per cent—and even this alloy has to be handled with great care, as there is always a tendency to porosity, because the zinc is so low that no margin of safety is allowed.

Phosphorus is a much more active deoxidizing agent than zinc, and when added to a copper and tin alloy, forms phosphor bronze. If the 2 per cent zinc in the alloy just given were replaced by 2 per cent of 15 per cent phosphor copper, it would make an excellent phosphor bronze, suitable for any class of work where a tough strong alloy is necessary. While phosphorus is a good preventive of porosity, it is not a specific, and phosphor bronze may produce spongy castings, when carelessly melted. In this instance it is the best agent that can be used to deoxidize the metal, and the defective castings should be remelted and run into ingots with the addition of 5 per cent of 15 per cent phosphor copper. These ingots can be proportioned among the new metal without any danger of producing porosity, in fact they will carry sufficient phosphorus to act as a preventive of porosity in future heats in which they may be used.

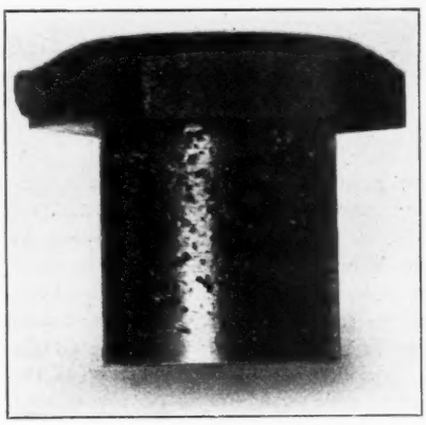


FIG. 3—SIDE VIEW OF POROUS BRASS CASTING

Prevention, however, is always better than cure. The formation of these holes in castings can always be avoided by proper care in melting. What has been said about the oxidation of copper makes it clear that every effort should be made to protect the metal while at a red heat. This is done by the use of fluxes and one of the best of these is common salt. It should be added at the commencement of the heat, and after the metal has begun to melt, the cold additions, which protrude above the charcoal, should be pushed into the liquid metal as they become hot. In this manner the metal is melted with a minimum of oxidation. The use of crucible rings also greatly aids in obtaining sound castings, as the ring in a great measure protects the metal from the oxidizing effects of the flame.

Brass Foundry Difficulties

SOLVED BY EXPERTS

Tobin Bronze.

We would like to have a mixture for Tobin bronze, and also wish to know the difference between Tobin bronze, Muntz metal and manganese bronze.

Tobin bronze is an alloy of copper and zinc with the addition of varying quantities of tin, lead and iron, a typical alloy being, copper, 57.50 per cent; zinc, 40 per cent; lead, 0.50 per cent; tin, 1.50 per cent; iron, 0.50 per cent. Melt the copper under charcoal, add the iron by means of yellow prussiate of potash, one pound. This is dropped on the charcoal covered surface of the molten copper and allowed to remain until the water of crystallization has been driven off, then cautiously stirred in. Heat 5 minutes, add the tin, 1 per cent being ordinary tin, ½ per cent phosphor tin. Ignore the lead and stir in the zinc, which should have been heated previously. Pour the metal before it flares. Muntz metal is the name usually applied to an alloy of copper, 60 per cent; zinc, 40 per cent, but these proportions are subject to change and the addition of other metals.

Delta metal is very similar and manganese bronze is also a near relation. The addition of a small content of aluminum, to improve their casting qualities, will convert any of these alloys into what can be called manganese bronze.

Shrinkage of Flat Copper Bars.

We have a quantity of flat copper bars to make, 14 inches long, 3 inches wide and 1½ inches thick. The castings are molded flat, the flask inclined. The metal poured at the upper end is carried by a long runner to the bottom of the mold, entering the bar at the lowest end, so that it runs up hill to form the casting. Although we place a heavy feeder on the upper ends of the bars, the castings have a depression in the center, which a straight edge shows to be from 1-16 to ¼ inch deep. The bars are not as clean as we would like to have them. The mixture we are using is copper, 100 pounds; silicon copper, 1½ pounds; the metal is quite solid and otherwise satisfactory.

Your trouble is one of molding only, and the remedy is to mold the bars edgewise instead of flat, using the same gate, runner and riser, as no improvement can be suggested in this respect. Copper, deoxidized with silicon, is so dense that the shrinkage is high. The metal is also fluid and does not chill as readily as other metals from contact with the cool mold. This makes it more difficult to feed up the shrinkage, because when a metal, in cooling, has formed a shell sufficiently thick to retain the form of the mold, the portion still liquid in the center is kept fluid by the hot shell, and when it contracts, drains from the highest to the lowest point. The feeder, therefore, supplies

metal to the casting, with the result that it is solid and true to pattern.

In the case of copper containing silicon, its fluidity is such that it does not cool in contact with the mold to form a shell sufficiently thick to support its own weight, and when contraction takes place, the shell in the upper part of the casting caves in, solidifying the fluid portion beneath and preventing drainage from the feeder. Therefore, the smallest surface of the casting should be exposed in the cope, so that when the heavier portions underneath begin to contract, the upper part will be bridged by a shell of metal sufficiently thick to support its own weight. The casting, therefore, maintains its shape.

When it is impossible to mold a casting without exposing a large surface in the cope, exceedingly heavy feeders must be used, or the upper surface can be chilled by iron chills or by the use of some heat conducting substance like carborundum fire sand.

Statuary Bronze.

Will you please inform me as to the composition of statuary bronze?

From the years 1860 to 1880, the following alloy was specified by the United States government: Copper, 90 pounds; tin, 7 pounds; zinc, 3 pounds; lead, 8 ounces. This has been superseded, and the following is now used: Copper, 90 pounds; tin, 5 pounds; zinc, 5 pounds; lead, 8 ounces.

Introduction of Phosphorus in Bronze.

We desire to know the safest method of introducing phosphorus into molten bronze. We use the yellow phosphorus, and when making phosphor bronze some time ago, had an accident in which two men were quite seriously burned, which was probably due to the fact that the sticks of phosphorus were not thoroughly dry, or that some drops of water were put in the metal with the phosphorus. Our method was to withdraw the crucible of molten bronze from the furnace, place it on the floor, then take the sticks of phosphorus from the can, in which it was submerged under water. After this had partially dried, it was put on a shovel and then slid off the shovel into the metal. A crowfoot-shaped instrument was then used to push it to the bottom of the molten metal, until absorbed. As far as we can judge, in doing this, the shovel probably touched the metal, and being damp, caused it to sputter, throwing the phosphorus in all directions, and in this way caused the accident. As we manufacture electrical machinery, we have large amounts of scrap copper, therefore we do not wish to buy phosphor bronze and prefer to make our own.

Yellow phosphorus is a very dangerous substance, either to handle or to have in stock in the foundry, and we do not recommend its use. The best manner of using phosphorus is through the medium of phosphor-copper, an alloy of copper and phosphorus, containing from 10 to 15 per cent of the latter element. The 15 per cent phosphor copper is very convenient, and is as safe to handle as any other metal. By its use, definite proportions of phosphorus can be added to alloys, which is not possible with yellow phosphorus, because a variable percentage burns to waste and does not enter the metal; therefore, the use of yellow phosphorus is wasteful and uncertain, as well as dangerous.

The 15 per cent phosphor-copper is a brittle, black alloy, easy to break into pieces suitable for alloying, and as it adds its weight to the metal, all things considered, is much more economical than yellow phosphorus. If it is preferable to use yellow phosphorus, however, the safest manner in which to add it is while the metal is in the furnace, as the danger of burns from spattering and explosions is thus reduced to a minimum.

The method of adding the phosphorus when the metal has been withdrawn from the furnace is very dangerous, and should never be permitted. Furthermore, phosphorus should never be thrown onto a skinned surface of metal, whether in the furnace or out, because the phosphorus is always damp, and if it comes into intimate contact with the melted metal, the thin film of water is instantly vaporized into steam, causing an explosion more or less violent, and which may result in throwing the inflamed phosphorus around like an exploding projectile.

The surface of the metal should be covered with a thin cover of charcoal. The phosphorus is dropped onto this wet, as it is foolish and unnecessary to attempt to dry it. The charcoal forms a raft on which the stick of phosphorus rides for the brief period necessary to vaporize the water, when the phosphorus inflames and should be stirred into the metal. It is advisable to add the phosphorus to the metal when the pot is about two-thirds full of melted metal, then the sides of the pot intercept any flying pieces of phosphorus, which again fall into the bath and are stirred in. After the phosphorus is added, the cold metal, which must be also melted to complete the charge, should be laid on top of the pot until heated before being pushed into the metal.

The phosphorus is carried to the furnace in a suitable tin cup under water, the cover of the furnace is partially opened, and a piece of the phosphorus tossed onto the metal, and stirred in as stated. The percentage of phosphorus lost is not as great as might be supposed. Take two pieces of equal size, toss one onto the metal, give it a light stir so the charcoal parts and it comes into contact with the metal, at the same time throw the other piece onto a hot plate on the floor and observe how much longer the latter piece will burn than the one thrown onto the metal. This will give an idea of how the metal absorbs the phosphorus.

Alloys of Copper and Lead.

We would like to make a metal containing 80 per cent copper and 20 per cent lead. We have experienced trouble in retaining the lead in the alloy, as it does not unite, but sinks to the bottom of the castings.

Alloys of copper and lead are being made in all proportions, the lead being held in the copper by means of fluxes when the proportion of lead reaches 50 per cent or over. Up to 30 per cent lead no flux is necessary, provided a small percentage of tin is present. Plastic bronze is an alloy of 65 per cent copper, 30 per cent lead and 5 per cent tin, and no difficulty is experienced in casting the alloy when the copper is carefully melted under charcoal. An alloy of copper, 73 per cent; tin, 7 per cent, and lead, 20 per cent, makes an excellent bearing alloy. If too hard for your purpose, the tin can be decreased, the copper being proportionately increased. Nickel and manganese will also aid in retaining the lead in the copper-lead mixtures, their action being to promote an early solidification of the copper, which entraps the still liquid lead, holding it in the interstices of the metal.

Fluxes have a different action. They do not promote this early solidification of the copper, but make the copper spongy or porous, and only such fluxes as will do this are of value in this connection. The lead is then held in the minute openings of the copper precisely as water is held by a sponge. This is the principle underlying the making of all so-called copper and lead alloys, which contain no other metal than copper and lead.

When properly alloyed or mixed, equal proportions of copper and lead should present a uniform bluish gray fracture which is as near homogeneous as such "alloys" can ever be. It is very seldom, however, that such perfect alloys are formed in commerce. Generally there is a plentiful admixture of reddish brown spots which often cover a large area of the casting, even showing themselves on the upper surface of the same. This is due to the use of too much flux, or of an improper combina-

tion of fluxes. The copper is too greatly aerified and the lead drains away through the spongy mass, as there is not sufficient to completely fill the pores, and the structure of the alloy at the point of drainage is changed and presents a coppery tinge. This is generally found on the center of bars cast on an incline. The lead flows to the lowest point through the copper matrix, draining from the center because the gated end is fed from the gate. Therefore these spots are usually found at or near the center of castings and can be prevented by using no more flux than is absolutely necessary to hold in the lead, also by a rapid chilling of the casting to solidify the lead before it begins to drain, which takes place after the copper has set. Rapid chilling is promoted by the use of carborundum fire sand for making the molds.

Effect of Chromium on Brass Alloys.

What is the effect of chromium on brass alloys; can ferro-chrome be used for making the alloy?

A method of adding chromium to brass was patented Dec. 14, 1909, by S. C. Peck and W. R. Hodgkinson, London, England. This makes a brass rich in chromium phosphide by a roundabout process, which is then used in adding the chromium to ordinary brass with, the inventors claim, a great increase in tensile strength and an enormous increase in elongation—as high as 72 per cent in 2 inches. Ferro-chrome can be used in brass, but it is very difficult to alloy because of its refractoriness. The chrome was first alloyed with the copper, 10 pounds of which was melted under charcoal, and 10 ounces of 60 per cent ferro-chrome gradually added in powder. The metal was strongly heated, and when alloyed, was poured into strips in sand molds. The metal ran solid, the castings were red externally, marked with the green colors of chrome and the alloy was cold short, breaking easily.

This chrome copper was added to different alloys of brass and bronze in various proportions, but did not increase tensile strength or elongation. On the contrary, it decreased the latter in a remarkable degree. The only value it seems to have in bronze is that it imparts brilliant coloring to the castings.

Red Brass.

I would like to know how to mix red brass so that the metal will have a reddish color when cast, and how to make red brass, using only scrap. Which is best, wet or dry tumbling, and if dry is better, what should I use to fill in with?

A good mixture for red brass consists of copper, 87 pounds; tin, 5 pounds; zinc, 3 pounds; lead, 3 pounds. The mixture can be made of new metal entirely or with any proportion of scrap metal desired. For instance, the charge for a No. 35 crucible could be half the above mixture and half scrap brass, or one-third new metal and two-thirds scrap.

Wet tumbling is always best for brass castings and the skimmings from the brass pots should be tumbled with the castings. This cleans them and also recovers the brass from the skimmings. The tumbling barrel should not be packed too tightly, but it must be full and if there are not sufficient castings, pieces of wood can be used to advantage.

Brass Fluxes.

Is it advisable to use a flux when melting brass, and if so, what is the best? It there anything better than soda ash?

A good flux to use with brass is common glass, which fuses and covers the surface of the molten metal. Salt is also good, but can be used only in small quantities because a pungent, irritating gas is evolved when pouring the metal which is very bad to breathe, as it causes violent fits of coughing. This gas is chlorine. Most fluxes attack the crucible and this is especially the case with soda ash, to minimize which it is mixed with sand. No flux should be necessary, provided charcoal is used, in ordinary melting. Charcoal reduces the oxides to metal and at the same time covers the liquid, protecting it from oxidation, as it possesses a greater affinity for oxygen than does the alloy.

Soda ash is of value in melting skimmings or sweepings containing sand, as it unites with the same, forming a liquid slag, through which the metal sinks into a pool below. Unless some flux is used to liquify the sand and dirt, it forms a stiff paste when strongly heated, which entangles and retains the metal in the form of shot, which is difficult to recover when cool, as the slag is strong and difficult to pulverize. When melting this material, therefore, soda ash should always be used.

Prolonging the Life of Crucibles.

Is there any method by which the life of crucibles can be prolonged? Also can holes be patched up when they develop in otherwise good pots?

The life of crucibles can be considerably prolonged by daubing from time to time with a mixture of three parts carborundum fire sand and one part of kaolin, or any good refractory fire clay. The pot should be first scaled, then soaked in water, and painted with a mixture of half silicate soda and water. Then the daubing, which should be mixed to a mud, is painted on with a paint brush, after which the pot can be dried. No especial precautions are necessary to prevent scalping, as with new pots. They can be returned to the furnace immediately after the coating has dried. The daubing should be commenced about the sixth heat and be renewed every three heats thereafter, two shifts of crucibles being worked, so that the pots that are daubed one day are not used until the next.

It is a difficult matter to patch up holes, as they are very rarely clean punctures, but are usually accompanied by a ramifying flake crack which does not show either inside or outside the pots. Generally this crack fills with liquid metal, which sets and when reheated expands, the action being similar to that of frost, so that a new leak soon develops. A clean puncture can be plugged, but it rarely holds long for heats of high temperature.

Formula for White Bronze.

I would like to have a good formula for making Parsons' white bronze; also, can iron and copper be alloyed so that the iron will be properly mixed and not exist as nodules, and if so, what effect does iron have on the copper?

The following formula makes an excellent "white brass:" Tin, 57.5 per cent; antimony, 1.5 per cent; copper, 2.25 per cent; zinc, 38.75 per cent; aluminum, ¼ ounce.

Iron and copper will alloy perfectly provided the iron is free from carbon. There are several ways of accomplishing this. The University of Wisconsin makes pure iron in the electric furnace, and then alloys it with copper. Commercially the same thing is done by melting the copper under charcoal and adding the iron in the form of a thin sheet, and when perfectly melted, the carbon is removed by chemicals having a greater affinity for carbon than has iron, just in the same manner as copper is deoxidized by such chemicals as phosphorus.

Iron tempers copper, making it stiff and springy. By its use copper bells can be made of good tone. The tensile strength of a copper-iron alloy was 50,000 pounds per square inch, elongation 50 per cent in 2 inches.

A Sonorous Aluminum Alloy.

We would like to know what is best to alloy with aluminum to make a sonorous alloy suitable for house door bells.

The following alloy will be found to fill the requirements: Chrome copper, 8 ounces; tin, 5 ounces; aluminum, 5 pounds. To make chrome copper for this purpose, to every pound of melted copper add 1 ounce of powdered, 60 per cent ferro-chrome.

PROBLEMS OF THE BRASS FOUNDRY

In the production of brass and aluminum castings for automobiles --- Economies effected by the use of molding machines

TO MEET the constantly growing requirements of the automobile industry for brass, bronze and aluminum castings, brass founders making a specialty of this line of work have not only been compelled to increase the output of their shops, but in addition have been forced to add labor-saving appliances, notably molding machines, not only to reduce cost of production, but to manufacture castings with greater dispatch. Motor car sections, with few exceptions, are not designed to facilitate the foundryman's labors, but despite the weird and intricate forms of many of the castings, the patterns, in many shops, have been successfully mounted on molding machines, resulting not only in an increased output, but a greatly reduced cost of manufacture.

The Standard Brass Foundry Co., Cleveland, makes a specialty of automobile castings, being equipped for their production in aluminum, brass or any of the bronzes. This concern has recently increased its producing capacity by the erection of an addition, which will be devoted largely to aluminum work. Molding machines are used extensively throughout the plant, and on floor work, the reduction in costs as compared with hand labor is marked. For large molds rock-over drop molding machines, installed by Henry E. Pridmore, Chicago, are used.

Machine-Molded Oil Pan.

A pair of Pridmore machines for molding the lower half of an aluminum crank case oil pan, are shown in Figs. 3 and 4. Plaster match-plates are used, the pattern forming a part of the drag plate, while the cope plate is made entirely of plaster. The flask is 20 x 42 inches, the cope being 5 inches deep, and the drag, 8 inches. Each machine is operated by one molder and one helper, while a laborer is employed to shake out the molds. The molders pour the work and the output averages 20 castings daily. When made on the floor, using a metal pattern on a follow-board, one molder and one helper produced four molds, the machine method, therefore, having more than doubled the output of these men. One of these castings cleaned, and another without the gates removed, are shown in Fig. 2. It will be noted that the two sprues are located in diagonally opposite corners of the mold, and 10 gates are provided to facilitate the flow of the metal into the mold as quickly as possible. To rapidly set the metal in the heavier sections of the casting, and to prevent these parts from drawing away from the lighter portions of the oil pan, no less than 26 chills are used in the cope and drag. It will be noted that the large green sand core is carried entirely in the cope, and in addition, three cores are set in the drag. Plaster match-plates are used almost entirely on these machines, the cost of mounting the pattern in this way being very small when compared with the other economies effected.

Another pair of Pridmore rock-over molding machines are shown in Figs. 5 and 6. The flask is 26 x 15 inches, and two handymen average 60 molds daily. When made on the floor one molder produced from 12 to 14 molds per day. The drag machine is illustrated in Fig. 5 and the cope in Fig. 6. The pattern is a motor gear cover, cast in aluminum.

An Intricate Oil Pan.

That the motor car designer gives little thought to the difficulties en-

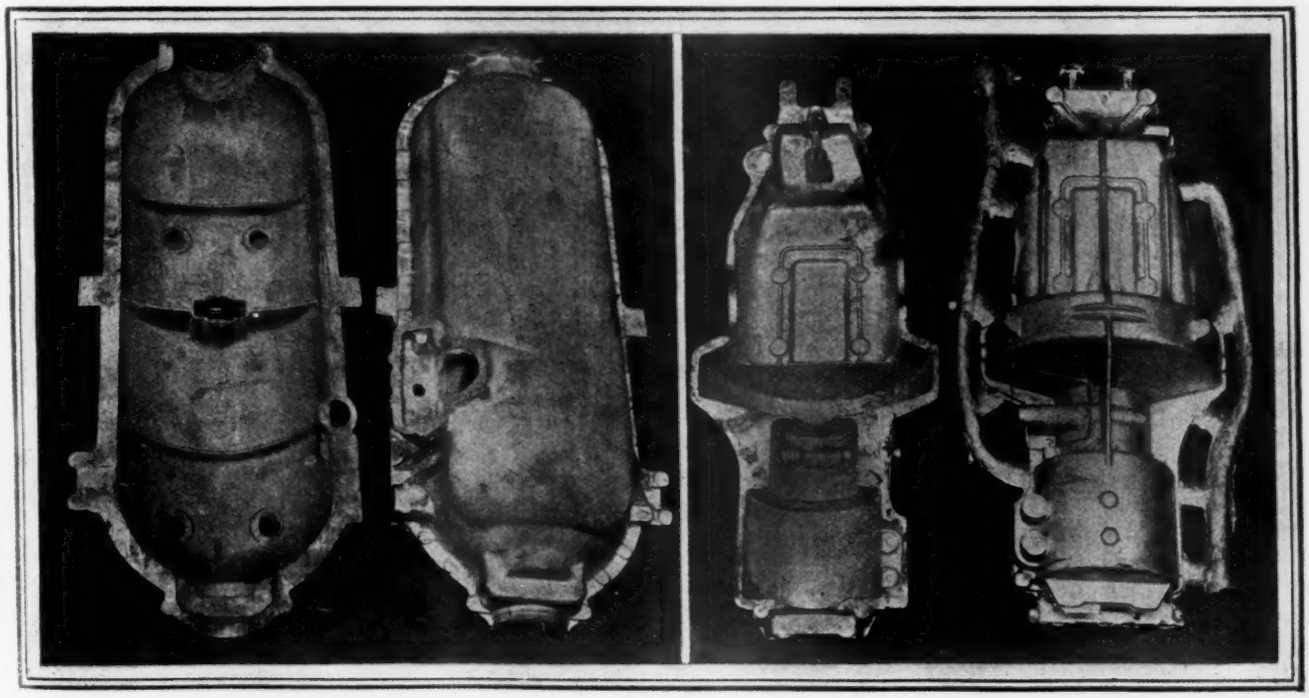


FIG. 1—INSIDE AND OUTSIDE VIEWS OF AN ALUMINUM OIL PAN FOR AUTOMOBILES

FIG. 2—INSIDE AND OUTSIDE VIEWS OF THE LOWER HALF OF AN ALUMINUM CRANK CASE

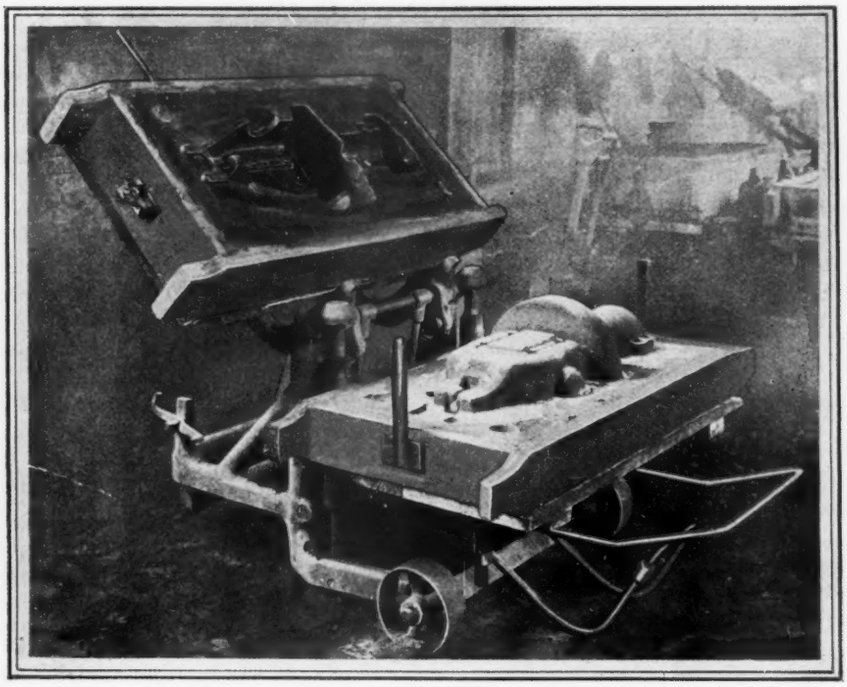


FIG. 3—ROCK-OVER MOLDING MACHINE USED FOR MOLDING THE COPE OF CRANK CASE SHOWN IN FIG. 2

countered in the foundry in the production of some of the intricate sections called for, is indicated by the aluminum oil pan, outside and inside views of which are shown in Fig 1. The oil flows through the four openings in the pan to a reservoir underneath, from which it is carried back into the oil circulating system through the opening in the back. The two parts of the core, as well as the core assembled, are shown in Fig. 10. In the upper illustration is shown the section of the core which forms the reservoir in the oil pan. It will be noted that the core tapers off to a sharp edge at one end, and great difficulties are encountered in the core room in providing vents in this thin section. This core is located by the four cores, which form the openings in the bottom of the oil pan, and great care must be exercised in setting this core to insure the proper metal thickness. A sweep is used for making the core, but the box is so designed that the thin section of the core must be tucked with the fingers and it is impossible for the coremaker to reach the tapered ends. For this reason the losses on these cores, unless care is exercised, are very heavy. The core is 40 inches long.

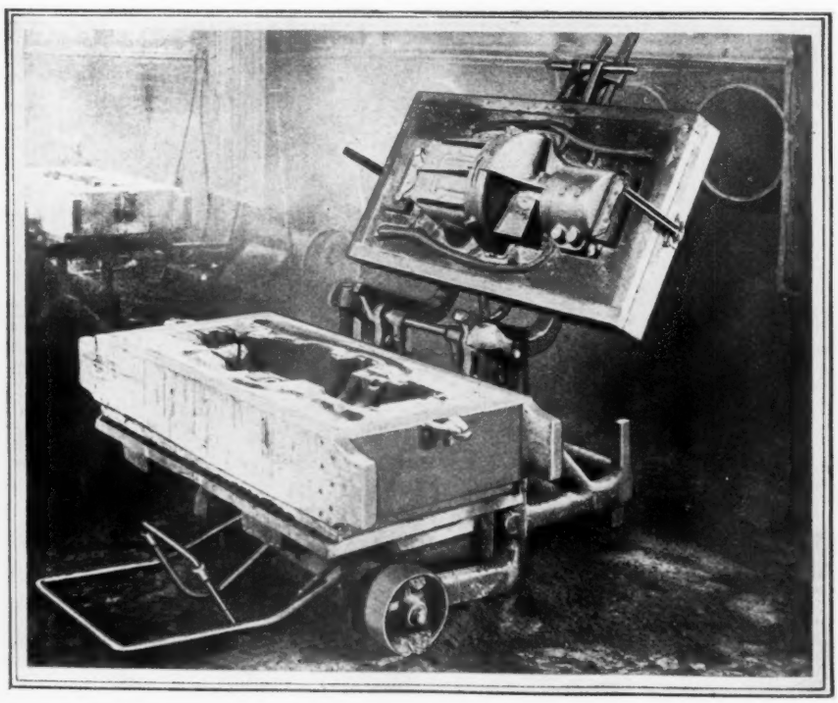


FIG. 4—ROCK-OVER MOLDING MACHINE USED FOR MOLDING THE DRAG OF CRANK CASE, FIG. 2

Manganese Bronze Motor Frames.

In Fig. 8 are shown two manganese bronze motor frames for electric cars, the one at the left having been photographed just after it was removed from the sand, to show the method of gating, while the casting at the right has had the gates removed. The mold for one of these frames is shown in Fig. 7. Owing to the high shrinkage of this metal no less than 52 chills are used in the mold to set the metal quickly in the heavier sections, and in addition, the mold is nailed almost throughout with copper nails. Owing to the uneven thickness of this casting, two manganese bronze cores are used in place of sand cores. The metal is poured through two sprues and enters the mold through six gates. The castings, with gates, sprues and runners attached, weighs 80 pounds, and cleaned, 56 pounds. The casting varies in thickness from 3/16 to 1 inch.

Core Ovens.

Fig. 9 shows a battery of three core ovens recently installed in the extension to the Standard Brass Foundry Co.'s plant by the J. D. Smith Foundry Supply Co., Cleveland. The battery consists of two car ovens and one rolling drawer oven, all gas-fired, but arranged for the use of coke in emergencies. The two car ovens are each 5 feet wide, 8 feet long and 6 feet high, each oven containing one roller bearing, all-steel frame, adjustable shelf car. The rolling drawer oven is provided with five drawers, 34 inches wide and 60 inches long. The two top drawers are 6 inches, the middle drawer 10 inches and the two bottom drawers 13 inches deep. The gas valves and air inlets are underneath the floor in a recess covered with perforated steel channels. Each drawer may be loaded with cores and returned to the oven very quickly, independent of the other drawers. The rear of each drawer closes the opening when the drawer is pulled out full length.

In the foundry, coke-fired pit furnaces are used for melting brass, and gas-fired, cast iron pot furnaces for

melting aluminum, although pit furnaces have been installed in the new addition for melting this white metal.

The molding machine equipment is to be further increased by the installation of two 32 x 32-inch, heavy duty, double shaft, roll-over stripping plate molding machines, built by Henry E. Pridmore, Chicago.

German Silver Mixture.

The Standard Brass Foundry Co. also makes castings for astronomical instruments, and has been very successful in melting mixtures containing high percentages of nickel. A German silver recently specified contained, copper, 57 per cent; zinc, 25 per cent, and nickel, 18 per cent. The nickel was placed in a crucible which was set down in the pit where it would be subjected to the highest temperature. The copper, in the form of cabbaged wire, was charged in a pot with the bottom removed, this crucible having been set over the pot containing the nickel. The copper was slowly melted, and drops of this metal, as fast as melted, fell into the molten nickel, thus insuring a thorough mixture. The zinc, owing to its comparatively low melting point, was added last.

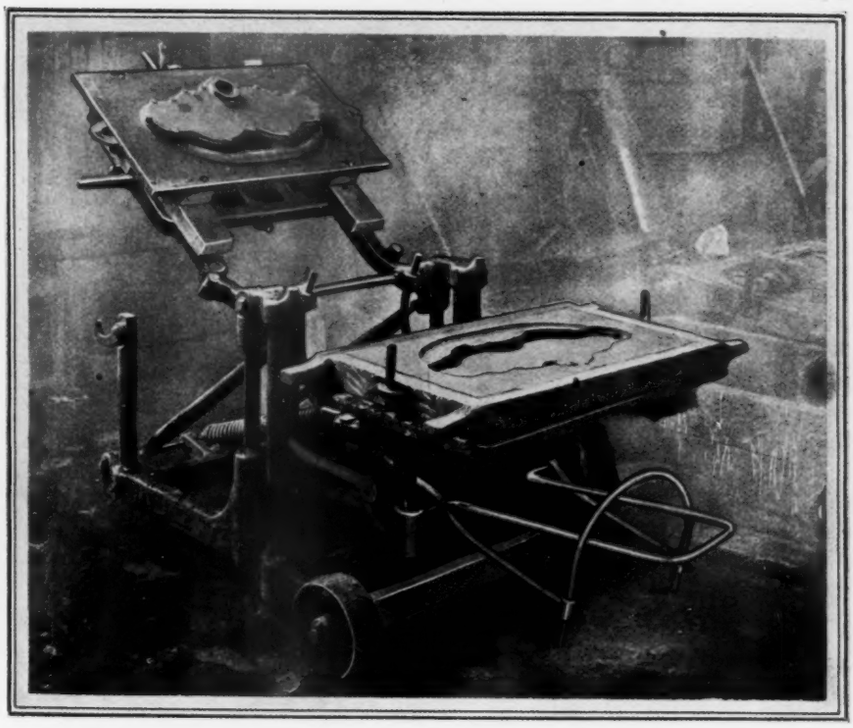


FIG. 5—ROCK-OVER MOLDING MACHINE USED FOR MOLDING THE DRAG OF AN ALUMINUM GEAR CASE COVER

BABBITT METAL.

GENUINE babbitt is an alloy of tin hardened with varying proportions of copper and antimony, according to the degree of hardness desired. A typical hard alloy follows: Tin, 83 1/3 per cent; copper, 8 1/3 per cent, and antimony, 8 1/3 per cent. This alloy must be poured at a high temperature when used for babbitt metal, otherwise it will run sluggish and does not properly fill out the bearing. The cause of this has been generally ascribed to the high percentage of copper, which raises the melting point of the alloy.

Experiments.

To determine the relative effects of copper and antimony in making babbitt sluggish, the following experiments were carried out. In the first trial 90 per cent of tin was alloyed with 10 per cent of copper and run into ingots. This alloy was fluid and tough but remained in a pasty condition a considerable time when setting. The ingot appeared solid but when touched was found to be mushy. When the alloy was poured hot, the oxidation of the metal was a reddish yellow and when broken the fracture of the ingot was neither fibrous nor crystalline, but a mixture of the two. The next experiment was made with a mixture containing tin, 80 per cent, and copper, 20 per cent. This metal ran very sluggish, the ingots showed feathery crystals on top and the metal remained pasty for a considerable period. The fracture was very coarse, short and easily broken, the metal was crystalline and sounded dead.

Ninety Per Cent Tin.

The next alloy tried contained tin, 90 per cent, and antimony, 10 per cent. This was very fluid and the metal

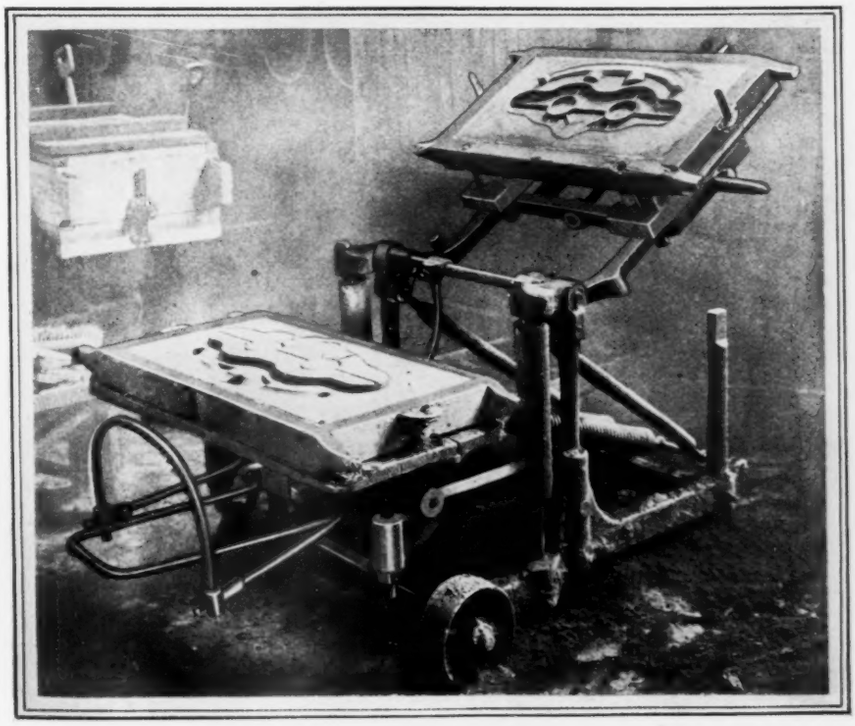


FIG. 6—ROCK-OVER MOLDING MACHINE FOR MOLDING THE COPE HALF OF GEAR CASE COVER

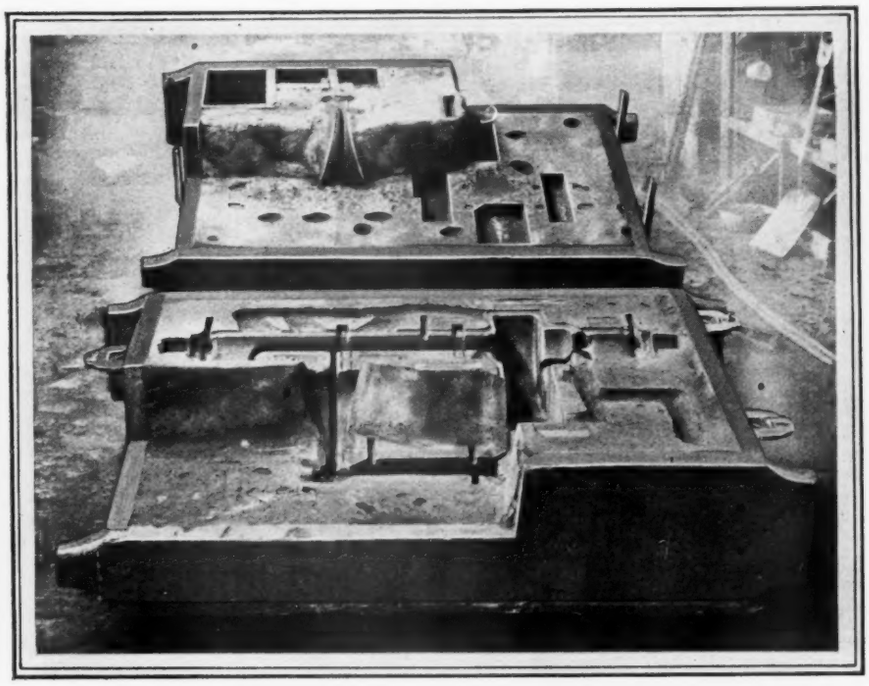


FIG. 7—MOLD FOR MANGANESE BRONZE MOTOR FRAME

was so tough that it could not be broken without first being cut. The ingots solidified rapidly and no pasty condition could be noted. The antimony was next increased to 20 per cent, with 80 per cent of tin. This alloy was fluid, set quickly, was tough, but in this respect was not equal to the 10 per cent copper mixture.

With 30 per cent antimony and 70 per cent tin, the alloy is exceedingly fluid and the ingots, which set with a glistening top, were very smooth. The fracture was dense, bright and sparkling, and the metal was brittle, hard and of no practical value.

Effects of Antimony and Copper.

These experiments proved that antimony has no bad effects on the fluidity of tin, but rather the reverse, and that it makes useful alloys up to 2 per cent of the entire mixture. Copper greatly decreases the fluidity of the tin. and it was found that it was this element that produced sluggishness, contrary to what might have been expected. It was also found that it retarded the setting of the tin and although it raises the melting point, it causes the alloy to remain in a semi-fluid condition for a considerable time. For this reason it is not advisable to use more than 10 per cent of copper in tin babbitt, otherwise the metal will be too sluggish to run.

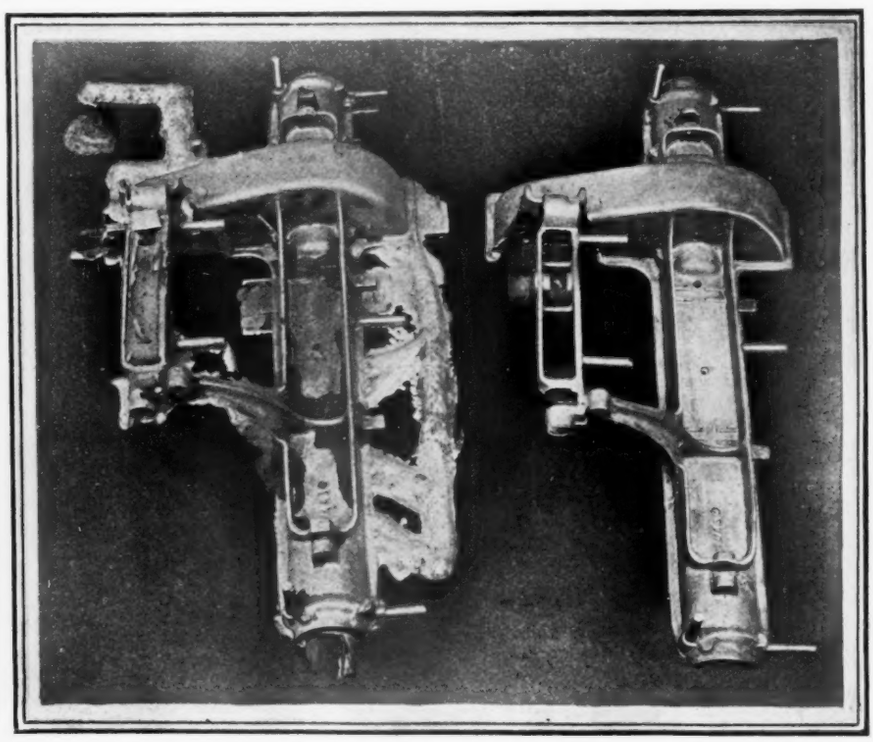


FIG. 8—MANGANESE BRONZE MOTOR FRAMES

ALUMINUM COOKING UTENSILS.

Complaint is occasionally made that aluminum cooking utensils turn black. This is due to the copper, which has been used in sufficient amount to form a black sulphide of copper on the surface of the metal. However, the greatest portion of this difficulty can be attributed to the action of ammonium salts, which gradually attack the surface of the metal, leaving behind a coating containing silicon, which is readily attacked by concentrated alkali. This coating has no injurious action and may be removed by treating the aluminum with caustic alkali. The metal should be rubbed with a cloth dipped in the alkali, in a way to avoid the too serious corrosion of the aluminum. Care should be taken when using caustic alkali not to burn the hands.

Aluminum can easily be kept free from corrosion by the same care that is usually bestowed upon other bright metal. Pure aluminum is not as readily corroded as its alloys. If the aluminum has been overheated in its molten condition it is liable to occluded gases, which result in an open, porous metal, easily corroded. All aluminum surfaces, after being wet, should be carefully dried.

The use of aluminum in cheap brass mixtures has sometimes occasioned the complaint that the surface of the castings is turned black by the use of this white metal. This is due to the sweating out of the lead, which the brass has contained.

METAL PATTERNS.

A white metal that is recommended for pattern plates contains lead, 90 per cent, and antimony, 10 per cent. This mixture has a very low shrinkage. A harder metal for pattern plates contains zinc, 66 per cent, and tin, 34 per cent. An amalgam for filling holes that cannot be soldered easily can be made of

filings of this alloy and mercury. This can be kneaded in the hands into a stiff dough and all of the mercury possible should be squeezed out. This amalgam is then pressed into the cavities and when hard, it may be scraped or filed like the metal itself. Type metal mixtures, which have given good results for metal patterns, follow: (1) Lead, 61.3 per cent; antimony, 18.5 per cent; tin, 20.7 per cent; (2) lead, 55 per cent; antimony, 30 per cent; tin, 15 per cent; (3) lead, 55 per cent; antimony, 22.7 per cent; tin, 22.3 per cent.

ALUMINUM IN GERMAN SILVER ALLOYS.

Aluminum is a valuable ingredient in brass and German silver alloys, when introduced in the proper amount. Brass founders generally experience difficulties in casting a German silver alloy containing copper, 62 per cent; zinc, 20 per cent, and nickel, 18 per cent. The metal, even if properly melted, will be sluggish, and when poured very hot, it will frequently fail to run in the mold. When successfully cast, the castings are frequently full of blow-holes, sand burnt, and the surface is covered with pin holes.

A small amount of aluminum added to this alloy will greatly improve its casting qualities. The fluidity will be increased, and it can also be poured at a lower temperature. Approximately ¼ of 1 per cent of aluminum will overcome all of the casting troubles generally experienced.

ALUMINUM-ZINC ALLOY.

Experiments made at Woolwich, England, to obtain an alloy having a specific gravity of not more than 3.5, a yield point of not less than 17,000 pounds, and a tensile strength of 26,000 pounds, with an elongation of 7 per cent, showed that an alloy of 80 per cent aluminum and 20 per cent zinc gave fairly satisfactory results.

THE PANAMA FOUNDRY.

The Gorgona shops and foundry, operated in connection with the construction work on the Panama canal, compare favorably with some of the largest plants in the United States. So heavy has grown the demand for gray iron castings that the foundry has been increased in size by the erection of an extension, 145 x 18 feet, and additional room will be procured by the removal of the brass foundry into the old pattern storage shed, which will be vacated when the new pattern storage building is completed. A casting pit will be constructed of concrete, and it will be served by a 10-ton jib crane. The largest work on which the foundry is now engaged are castings for caisson seats in the locks, as well as sections to serve as lock linings. An order will also shortly be placed for about 600 tons of counterweights for regulating gates. The output of gray iron castings in January was 444,830 pounds, for which a charge of 3 cents was made. In the new brass foundry, three oil burning furnaces will be installed, and in January the output of the brass department was 31,304 pounds, for which a charge of 18 cents a pound was made. The prices quoted for brass and iron castings include the cost of supervision, plant charges, all pattern work and other costs.

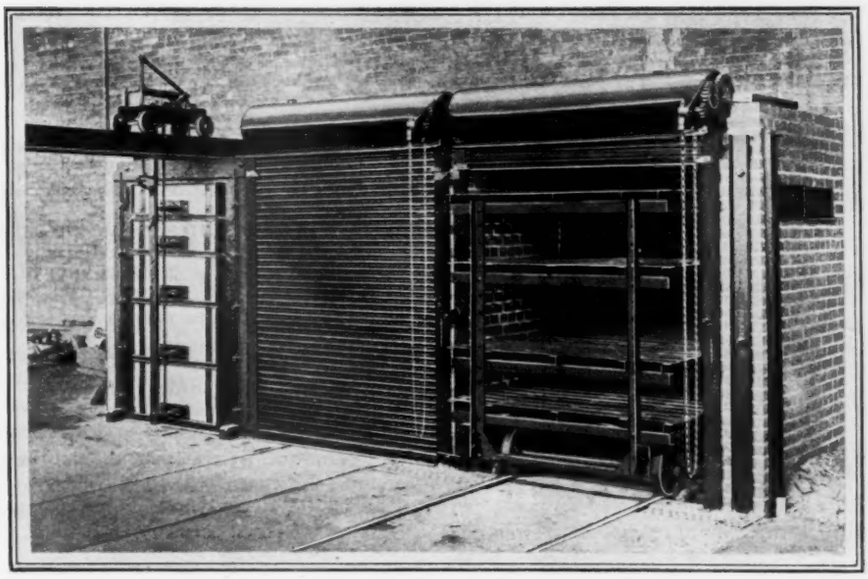


FIG. 9—BATTERY OF THREE COKE OVENS IN STANDARD BRASS FOUNDRY CO.'S PLANT

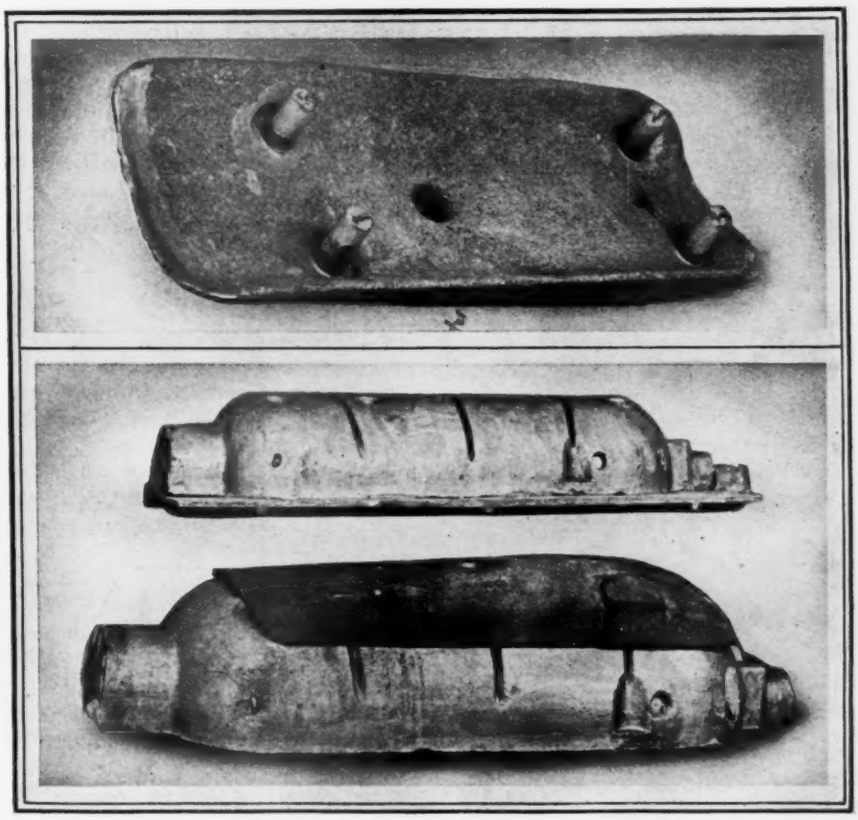


FIG. 10—COKE FOR ALUMINUM OIL PAN

SILVER CUPS FOR EXHIBITS AT DETROIT

To be awarded by The Foundry for the best still and operating exhibits --- Preparations for the convention of the allied foundry organizations --- Entertainment features including boat ride and smoker

REPORTS of the chairmen of the various committees for the reception and entertainment of visiting foundrymen at Detroit during Founders' Week, June 6-10, were presented at the monthly meeting of the Detroit Foundrymen's Association, held Thursday, April 21. Joseph J. Wilson, chairman of the plant visitation committee, reported that all of the Detroit foundrymen will be pleased to receive visiting delegates at their shops, and those desirous to inspect plants while in attendance at the convention, can obtain all of the necessary information from the headquarters of the visitation committee, either at the Fair Grounds or at the Pontchartrain Hotel. A folder will be issued containing a map of Detroit, showing the location of the plants to be visited, car lines, etc. A list of all of the plants will be included, with directions as to how they may be reached. If a party of foundrymen desire to visit a certain shop, a card will be issued to one, which will gain admission for himself and party. Small parties on these tours of inspection are preferred, as it has been found at previous meetings that large delegations cannot be taken care of to good advantage.

Boat Ride.

Oliver Phelps, chairman of the boat ride committee, stated that the steamer Columbia has been chartered, which has a capacity of 3,400 passengers. The Columbia will leave the dock shortly after noon and after a trip on the river, which will give the visitors a good view of the city, a stop will be made at the plants of the Detroit Iron & Steel Co. and the Solvay Process Co. The stop at the blast furnace plant will be so arranged that the visitors will have an opportunity of witnessing a cast. Both plants are extensive and are among the largest in Detroit. The boat will return to the dock at about 6 o'clock, in time for dinner, and, as she has also been chartered for the evening, will leave again at 7:30 or 8 o'clock for a moonlight ride. There will be music both afternoon and evening, and light refreshments will be served. Tickets for the boat ride will be distributed to the members of the various organizations at the registration desk.

On Monday evening, June 6, a dinner will be tendered the officers of the allied foundrymen's organizations and the representatives of the technical press at the Hotel Pontchartrain, by the Detroit Foundrymen's Association.

Smoker.

Edward J. Woodison, chairman of the entertainment committee, said that it has been decided to present a varied vaudeville program at the smoker and it is probable that suitable souvenirs will be distributed, the nature of which has not yet been fully determined. Ample provision will be made for the entertainment of the visitors, and the smoker promises to be one of the features of the meeting.

The general registration headquarters will be located in the Michigan building on the State Fair Grounds, which can be easily reached by trolley, where the meetings of the various societies will also be held. W. P. Putnam, chairman of the sessions committee, reported that a large number of papers will be presented and the discussions will undoubtedly develop many points of interest and value not contained in the original addresses. A souvenir program is also to be published, and Edward J. Woodison, chairman of the booklet committee, stated that it would contain all of the necessary information regarding the convention, and in addition will serve as a guide for the visitors.

The Exhibit.

At a special meeting of the executive committee of the Foundry and Manufacturers' Supply Association, held at the Cadillac, Detroit, Friday and Saturday, April 1 and 2, final preparations were made for the exhibit of foundry supplies and equipment which will be held in the buildings of the State Fair Grounds. The space reservation already totals 30,000 square feet, and in addition to the three buildings a tent will be utilized for the exhibition of brass melting furnaces, core ovens, etc. The question of a permanent exhibit building was discussed at length, and a representative of the Chamber of Commerce of Niagara Falls, N. Y., told of the plans to erect a large exposition building in that city, where the annual shows of

SILVER LOVING CUP TO BE AWARDED FOR THE BEST OPERATING EXHIBIT AT DETROIT

SILVER LOVING CUP TO BE AWARDED FOR BEST STILL EXHIBIT AT DETROIT

manufacturers of foundry equipment might be held. A permanent building would effect great economies in the cost of installing exhibits, and the shows have become so large that the difficulties experienced in obtaining suitable halls in the various cities is constantly becoming a greater problem. Since the organization of the American Foundrymen's Association, it has been the plan to hold the annual meetings in different large foundry centers each year and the advisability of selecting a permanent location will be further considered at a joint meeting of the executive committees of the various organizations interested, during convention week.

INSCRIBED SIDE OF SILVER LOVING CUP TO BE AWARDED FOR THE BEST OPERATING EXHIBIT

All exhibits must be installed before the opening of the show, Monday, June 6, and goods received after the opening day must be arranged after the closing hour. Exhibitors who have operating displays must provide and connect their own motors. The current available is single-phase, 60-cycle, alternating at 110 and 220 volts; three-phase, 60-cycle, alternating current at 220 volts is also available for large motor installation. Uniform division railings between exhibits will be provided by the Foundry and Manufacturers' Supply Association. On account of the difficulty in supporting railings on concrete floors in the buildings, railings will not be provided in front of the booths. However, should any exhibitor desire a railing in front of his booth, he may construct the same, subject to the approval of the secretary. During the continuance of the exhibit, a nominal admission fee will be charged.

Silver Loving Cups.

Illustrations of the silver loving cups awarded by THE FOUNDRY for the best operating and still exhibits, are presented herewith. The cup for the best operating exhibit, with the base, is 19⅞ inches high, and is provided with two holders. The cup for the best still exhibit is 16¾ inches high and has three holders. Typical foundry scenes are etched on each cup and they are suitably inscribed in commemoration of the occasion. At the meeting of the executive committee of the Foundry and Manufacturers' Supply Association, a vote of thanks was tendered THE FOUNDRY, and President F. N. Perkins was authorized to appoint a committee of visiting foundrymen to make the awards.

American Brass Founders' Association.

A large number of papers are to be read at the meetings of the American Brass Founders' Association, the following already having been received: "Costs and Cost Systems Applied," by C. R. Stevenson, New York City; "Analysis for Lead in Brass Alloys," C. P. Karr, Nathan Mfg. Co., New York City; "Co-Operative Course of Metallurgy," Prof. J. J. Porter, Cincinnati; "Electric Furnaces for Melting Non-Ferrous Alloys," A. L. Marsh; "Fluxes as Applied to the Brass Foundry," Irwin S. Sperry; "Electric Power as Applied to the Melting of Brass, Bronze, etc.," by Prof. J. W. Richards, Lehigh University. Jesse L. Jones, of the Westinghouse Mfg. Co., Pittsburg, is also preparing a paper which will be presented at the Detroit meeting.

SODIUM AND PHOSPHORUS.

Sodium and phosphorus are both powerful deoxidizers of copper alloys, but they cannot be used together with advantage as they are exceedingly antagonistic, in fact so much so that sodium will expel the phosphorus from phosphor-tin.

In one experiment, two pounds of 5 per cent phosphor-tin were melted and two pounds of sodium-tin added, with the result that the metal turned into a pasty mass, more than half of which had lost the characteristics of a metal and had become a black, evil smelling, heavy mud, which on being stroked with the skimmer emitted flashes of phosphorus flame. The alloy could not be run into ingots as it was entirely turned into a paste, which emitted an overpowering smell of prosphorus.

WHITE SPOTS IN GRAY IRON CASTINGS.

BY W. J. KEEP

Question:—We have small spots of white iron, approximately the size of pin heads, in our castings, and we would like to know how this can be prevented. The castings are from ¼ to ¾ inch thick, and the white spots interfere with machining.

Answer:—Your silicon should be increased by the addition of a small amount of silvery iron. By experimenting, you can ascertain which of your pig irons causes the white spots and you can decrease the quantity of this grade used. A small amount of aluminum in the ladle will also eliminate the white spots.

INSCRIBED SIDE OF SILVER LOVING CUP TO BE AWARDED FOR THE BEST STILL EXHIBIT

SUMMER COURSE AT THE UNIVERSITY OF WISCONSIN.

The tenth annual session of the Summer Schools for Engineers and Artisans, under the direction of the College of Engineering of the University of Wisconsin, Madison, Wis., opens June 27. Advanced courses are offered in hydraulics, machine design, descriptive geometry, applied mechanics, shop work, steam and gas engineering, electricity and surveying. Elementary courses for artisans are offered in applied electricity, shop work, machine design, mechanical drawing, etc.

THE FOUNDRY

Published monthly by

The Penton Publishing Co.

CLEVELAND

BIRMINGHAM, ENG.....Prince's Chambers.
BUFFALO.....932 Ellicott Square.
CHICAGO.....1328 Monadnock Block.
CINCINNATI.....11 Blymyer Bldg.
NEW YORK.....1115 West Street Bldg.
PITTSBURG.....510 Park Bldg.
SEATTLE.....942 Henry Bldg.

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The subscription price of THE FOUNDRY is $1.00 a year in the United States and Mexico. To Canada, $1.50. To Great Britain, Eight Shillings. Single copies, 15 cents each. Back numbers, three months or more, 25 cents each.

Change of advertising copy must reach this office on the 10th of the month preceding date of publication.

The Cleveland News Company will supply the trade with THE FOUNDRY through the regular channels of the American News Co.

European Agents: The International News Company, Breams Building, Chancery Lane, London, E. C., England.

PAID CIRCULATION OF THE FOUNDRY

January, 1909	9,143
January, 1910	10,373
February	10,427
March	10,489
April	10,594
May	10,706

Entered as second-class matter at the Post-Office at Cleveland, O.

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To Foundry Proprietors

Have you made arrangements for the attendance of your foundry superintendent and foreman at the Foundrymen's Convention, which will be held in Detroit, June 6-10? If not, it is advisable to insure their presence in the City of the Straits during Founders' Week. It is the opportunity of the year afforded foundrymen to renew friendships, make new acquaintances and to exchange ideas on foundry practice. It is the only opportunity afforded your shop executives for an inspection of foundry supplies and equipment. Here will be displayed the latest and most improved labor-saving devices for the production of castings. Every manufacturer of equipment for the foundry trade will be represented and the number of operating exhibits will be larger than heretofore. Your superintendents and foremen will obtain many new ideas that will help swell your dividends. It is the best kind of business insurance—insure.

Trade Outlook

All branches of the foundry trade, notwithstanding the declining pig iron market, continue active and there is a marked tendency toward higher prices for all classes of castings. This is largely due to the demand for higher wages, common labor especially asking advances of from 10 to 25 cents per day. The scarcity of molders in all sections of the country is pronounced, and in the districts where the output of castings for automobiles is large, the shops, almost without exception, are running with insufficient help. Iron foundries, both specialty and jobbing shops, are operating at capacity, and prices for castings are higher than at any time during the last two years. The activity of the agricultural implement plants, notably in the central west, insures the steady operation of the malleable shops, and higher prices are being obtained for castings in contracts that are now being written. Steel foundries are also actively engaged and are operating at capacity to meet the heavy requirements of the railroads. Brass and aluminum foundries, especially those making a specialty of automobile castings, are unable to cope with the demand, and shipments are deferred from 30 to 60 days. The tremendous increase in brass foundry capacity is insufficient to meet the requirements of motor car manufacturers, and new shops that are being erected experience no difficulty in securing orders, providing prompt shipment is assured. Pig iron values show a further decline, which is due almost entirely to the heavy production, consumption being above normal. One large contract for Southern No. 2 was recently placed on the basis of $12.00, Birmingham, while malleable iron is quoted from $15.50 to $16.00, furnace. No. 2 foundry is quoted as follows in the various producing centers: Pittsburg, $16.90; Chicago, northern, $17.00; Cleveland, $16.50; eastern Pennsylvania, $17.25. Lake Superior charcoal is held at $19.00, Chicago, and basic, $16.90, Pittsburg. The non-ferrous metals remain practically unchanged in price, despite heavy sales. Importations of aluminum are growing heavier notwithstanding the heavy duty, and in many shops the foreign white metal is now being successfully used.

The American Foundrymen's Association

Another effort is being made by the American Foundrymen's Association to obtain an expression from its members relative to an increase in annual dues from $5 to $10. Last year the proposition was lost, as a majoity of the members failed to cast their ballots. The necessity for this increase in dues must be apparent to all the members of this society, as the funds at present are inadequate to meet expenses, and no appropriations can be made for investigations, experiments and research work, such as should be carried on by an organization of this kind. The membership has grown rapidly in recent years, due to the untiring efforts of the officers of this body, and as firms are largely enrolled, an increase in the dues would not result in the loss of many members. The educational organization of no industry has so successfully coped with almost insurmountable difficulties as that of the foundry trade, but despite the lack of funds, and at times of interest, work has been accomplished that is of incalculable value to all engaged in the production of castings. The dues at present are much lower than those of any other American educational society, and the benefits that will be derived from increased resources will more than repay the higher cost of membership.

Foundry Trade on the Pacific Coast

On the Pacific coast the manufacturing plants, especially those building logging and saw mill machinery, are well supplied with orders and are working full time. Foundries not connected with manufacturing plants, but engaged in general jobbing business are not doing so well although the condition of the

jobbing foundries is considerably better than it was during the winter. The labor bureau of the United Metal Trades Association reports a somewhat better demand for molders during the first two weeks in April. A number of projects involving round tonnages of building castings are yet to be placed. Prices for castings remain unchanged while pig iron prices, if they have moved at all, have dropped a little. Alabama iron is again approaching the point where it can compete with foreign brands on the north Pacific coast. It is possible that some of the annual allotment of 100,000 tons of Chinese iron, recently contracted for by the Western Steel Corporation of Seattle, will be offered to the trade.

PERSONAL.

John H. Robinson has resigned as vice president and general manager of the Fairfield Aluminum Corporation, Fairfield, Ct., and has disposed of his interest in that company.

Joseph H. Hansjosten, foreman of the plating and polishing department of the Rock Island Stove Co., Rock Island, Ill., has resigned to accept a position in a similar capacity with the Automatic Electric Co., Chicago.

R. D. Brooks, who has been associated with the International Steam Pump Co., New York, for many years, has resigned to became general manager of the Bayonne Casting Co., Bayonne, N. J., manufacturer and dealer in Monel metal.

A. Tropenas, president of the Tropenas Steel Co., New Castle, Del., has gone abroad on a business trip.

R. C. Harrison, Hyde Park, Mass., has been appointed foundry superintendent of the Lowell Machine Shops, Lowell, Mass.

A. S. Beam, formerly superintendent of the Trenton Malleable Iron Co., Trenton, N. J., has been appointed superintendent of the Waterloo Malleable Iron Works, Waterloo, Ia.

Frank McMurdie, superintendent of the American Blower Co.'s Detroit plants since 1894, has resigned to accept the position of general superintendent of the plant of the Clarage Foundry & Mfg. Co., Kalamazoo, Mich. Mr. McMurdie entered the employ of the American Blower Co. in 1883.

O. H. Davidson, formerly superintendent of the Davidson Foundry Co., East Chicago, Ind., and later connected with the Blair Engineering Co., Chicago, is now associated with the Calumet Engineering Works, Harvey, Ill., in the capacity of foundry superintendent.

Wm. C. Scott, formerly chief chemist of the City of Sandusky, in charge of its water purification plant, has accepted a position as chemist and metallurgist of the Bay View Foundry Co., Sandusky, O., and will take charge of this concern's metallurgical laboratory.

Henry D. Shute has been appointed acting vice president of the Westinghouse Electric & Mfg. Co., Pittsburg.

H. C. Waugh has been elected general manager of the Union Iron & Brass Works, El Paso, Tex.

ANNUAL MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS.

The thirteenth annual meeting of the American Society for Testing Materials will be held at the Hotel Traymore, Atlantic City, Tuesday to Saturday, inclusive, June 28 to July 2. Members have been invited to cooperate with the executive committee in its endeavor to make the program for the approaching meeting the best in the history of the society.

Inasmuch as the present dues of $5 per annum are insufficient to meet financial requirements, it has been suggested to increase the dues to $10 per year. If this carries, it provides for the publication of a year-book bound in cloth, which, in addition to the contents of the present annual pamphlet, will contain all standard specifications in revised form. The annual volume of the proceedings will also be supplied to members without extra charge for binding, and it has been proposed that a new class of junior membership be created, consisting of persons less than 30 years of age, for whom the annual dues shall be $5. In addition, the executive committee suggests the abolition of the contributory membership class on the ground that adequate annual support for the legitimate running expenses of the society should be distributed over the membership at large.

The large and constantly increasing number of technical committees has led the executive committee to authorize the adoption of a more systematic scheme of enumeration, which becomes effective May 1. The membership of the society is rapidly increasing, and has grown from 1,160 at the time of the last convention, to 1,266, a net gain of 106.

OBITUARY.

Joseph R. Hansell, of the firm of the Hansell-Elcock Co., Chicago, died in that city March 31, aged 75 years. He had been engaged in the foundry business in Chicago for about 40 years, and in 1888 became a member of the firm with which he was identified at the time of his death. Mr. Hansell retired from active business several years ago.

BOOK REVIEW.

Fuel and Refractory Materials.—By Humboldt Sexton, 5 x 7 inches, 364 pages, price $2.50; published by D. Van Nostrand Co., and furnished by THE FOUNDRY.

The second edition of this work has been revised and brought up-to-date, although no change has been made in its scope or general arrangement. Since the first edition was published there have been changes and developments in coke ovens, gas producers and pyrometry, which have received attention, and descriptions of plants, that had become obsolete, are changed to more modern practice.

The book will be found very instructive by users of fuels, and all engaged in metallurgical operations. The first 35 pages treat of the phenomena of combustion in a very complete manner, enabling the reader to better understand the chapters that follow on the heating power of different fuels, and the nature, classification, chemical composition and relative values of natural fuels. The process of making the prepared fuels is described, and the various forms of kilns and coke ovens are illustrated in detail.

A chapter on coke washing explains the object of this operation, and describes and illustrates the various machines used. Liquid and gaseous fuels receive attention and several pages are devoted to a description of the different types of gas producers, their operation and methods of using the fuel, with tables comparing different producers, giving the percentages of the various gases.

The recovery of by-products follow, also chapters on furnaces for metallurgical processes, pyrometry, calorimetry, the utilization and analysis of fuel and the manufacture and values of the various refractory materials.

The Calumet Engineering Works, Harvey, Ill., has received the following contracts for cranes; Hubbard Steel Foundry Co., East Chicago, Ind., one 35-ton, one 20-ton and two 10-ton; Mt. Vernon Car Mfg. Co., Mt. Vernon, Ill., three 10-ton; American Steel Foundries, Indiana Harbor, Ind., one 15-ton; International Harvester Co., Akron, O., one 5-ton and one 6-ton and two 12-ton for the McCormick plant, Chicago.

MODERN EQUIPMENT FOR THE FOUNDRY

Pneumatic roll-over molding machine --- Improved molding machines of the squeezer type --- Sherardizing process equipment

A PNEUMATIC roll-over molding machine, which jolt rams the mold, rolls it over, and draws the pattern, made by the Adams Co., Dubuque, Iowa, is shown in Fig. 1. This machine performs all of the operations necessary for making a mold, permitting the work to be done by a handyman or a laborer, no skilled mechanic being required. The machine is portable, one end being mounted on solid cast iron wheels, which operate on a track embedded in the floor, affording an ample foundation at a small expense. In addition, the wheels serve as the anvil while the mold is being jolted. The arm or table, made of steel angles, resting on the wheels, carries the pattern, and each side is provided with a steel block, *A*, Fig. 1, which receives the shock of the successive blows when the mold is being rammed. The pattern is attached to the table by bolts, which pass through the angle frame.

The flask in position on the table, filled with sand, is shown in Fig. 2, and in Fig. 3 the mold is being jolt rammed, this illustration showing the table raised above the wheels before striking the ramming blow. By operating one lever, air is admitted to the cylinder, exhausting through the same valve, permitting the molder to control the machine entirely with one hand. After jolting and striking-off, the bottom board is placed in position, and is secured by adjustable clamps attached to the match-board. These clamps are clearly shown in Figs. 2, 3 and 4.

After the mold has been clamped, the air valve is again opened, and air is admitted to the cylinder, raising the mold to dead center. After passing this point, the mold is lowered onto cross pieces *B*, Fig. 1, by allowing the air to exhaust. This can be done as quickly or as slowly as desired.

In Fig. 5, the mold is shown lowered onto the cross pieces supported by the four plungers *C*, Fig. 1, which rest on springs and automatically adjust themselves to the irregularities of the bottom board at four corners. When the mold rests upon the cross pieces, these plungers are locked in position by a single movement of lever *D*, Fig. 1, which is connected by links to the four plungers. This lever, being only slightly above the floor level, can be kicked into locking position with the foot.

The clamps are next released, and the pattern is drawn, as shown in Fig. 6. The molder operates the valve, which admits the air to the cylinder, with his right hand, and with his left hand opens a cock, which admits the air to the pneumatic rapper mounted on the frame carrying the pattern. The pattern is drawn absolutely straight to any desired height within the capacity of the machine before starting to roll over. The pneumatic rapper and the steady air control insure a clean lift. It will be noted that as cylinder *E*, Fig. 1, is raised by the air pressure, the pattern will be drawn straight until the yoke, *F*, strikes the pin, *G*, when the yoke must stop, making a fulcrum of the pin, *H*. The table carrying the pattern, as it is being rolled back to its original position to receive a new flask, after having passed dead center, is shown in Fig. 7. The machine is economical to install, as no foundations are required other than the track previously noted, and the clamping of the equalizing plungers with one lever is a feature which eliminates several movements of the operator, such as are necessary when each plunger is separately clamped.

An improved 24-inch Farwell squeezer is shown in Fig. 8. It is similar in construction to other stationary squeezers made by the Adams Co., except that

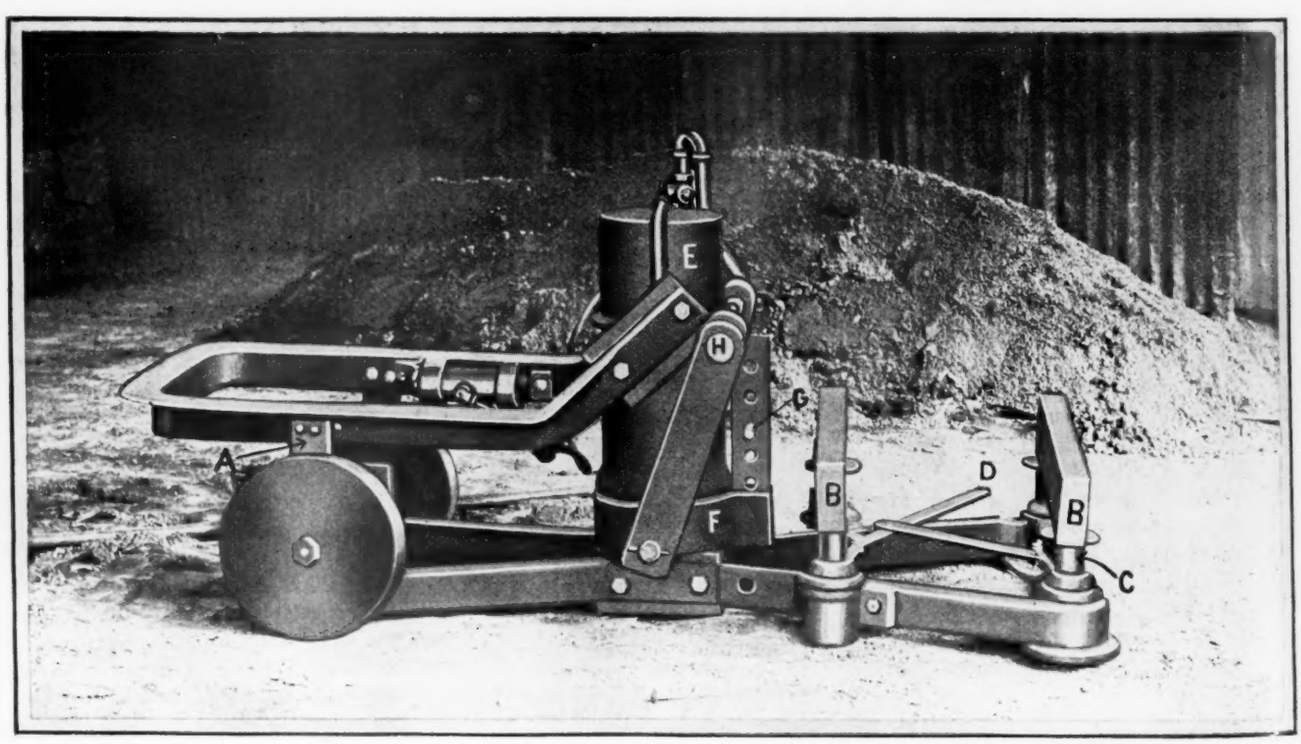

FIG. 1—PNEUMATIC ROLL-OVER MOLDING MACHINE

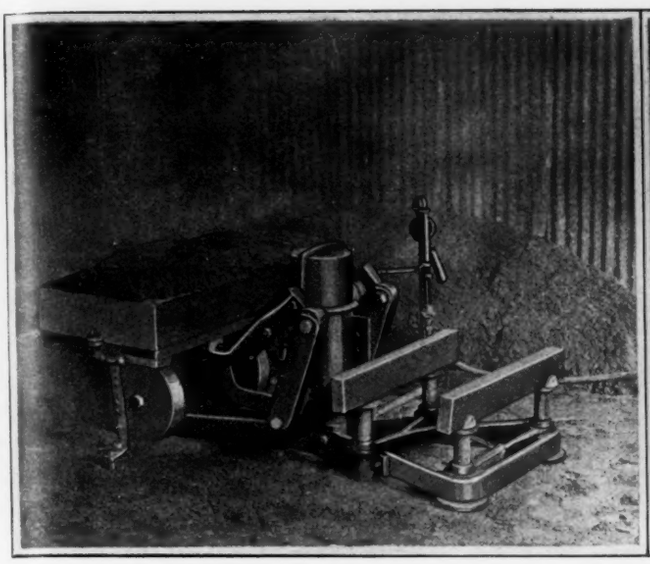

FIG. 2—FLASK IN POSITION ON PNEUMATIC ROLL-OVER MOLDING MACHINE

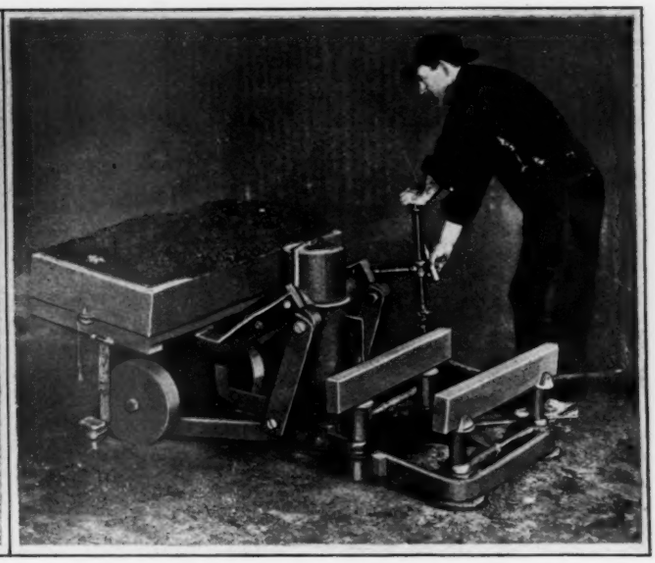

FIG. 3—JAR RAMMING THE MOLD

the table is raised higher above the rocker shaft and the top does not swing through so great an arc in clearing the table. This makes it easy to swing the top forward into squeezing position, while the new form of table brings the mold above the links, which connect the rocker shaft with the side arms, thereby making it possible to use a larger flask in proportion to the width of the machine, and removes the danger of the molder striking his knuckles against the links when riddling sand. This machine measures 24 inches between side rods, and will take a flask 18 inches long, or within 6 inches of the width of the machine. On the other hand, the ordinary 30-inch squeezer, which measures 30 inches between side rods, will not conveniently permit of the use of flasks longer than 22 inches. Fig. 9 shows a new, portable, low-down, heavy duty squeezer or plow-point machine. This type has, in the past, been built in 30-inch and 38-inch sizes only, and the 34-inch machine is a new addition to this line, possessing a number of special features. The principal improvement is the new style of counterbalancing spring, which is adjusted to any tension. It can be set so that the squeezer top will move forward automatically, but it is ordinarily adjusted so that the back is out of the molder's way until the mold is ready to be squeezed, when it is brought forward by a very slight pull.

The Adams Co. has also developed a new type of Farwell squeezer for use in connection with the Keep hinged match-plate system. This machine, with a number of changes, which adapt it to this process, was shown in the March, 1910, issue of THE FOUNDRY. The frame has been spread and is mounted on four wheels, a support for a riddle has been added at one side, while on the other side and at the back two shelves have been added for the flasks and the molder's tools. This machine is especially built for foundries that adopt the Keep system of match-plate molding.

THE SHERARDIZING PROCESS AND ITS EQUIPMENT.

Since the introduction into this country of the first commercial sherardizing plant by the Globe Machine & Stamping Co., of Cleveland, and the beginning of the manufacture of sherardizing equipment, the company has recognized that the success of the

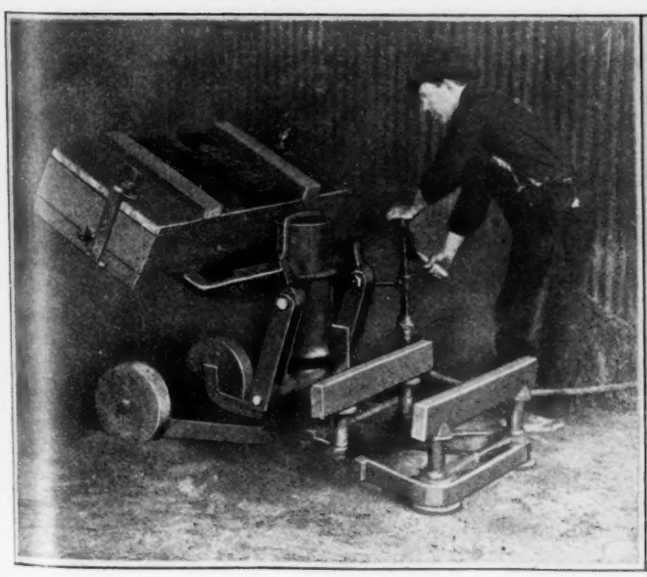

FIG. 4—ROLLING OVER THE MOLD AFTER RAMMING

FIG. 5—MOLD ROLLED OVER IN POSITION ON THE EQUALIZING BARS

FIG. 6—DRAWING THE PATTERN

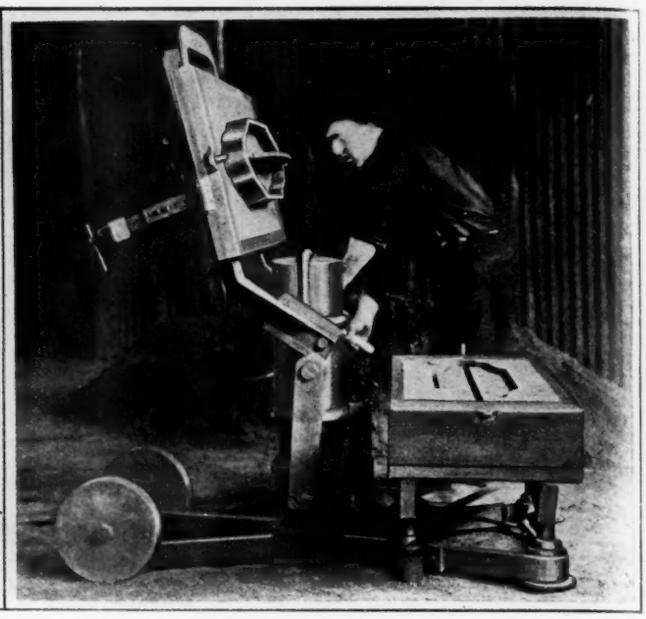

FIG. 7—ROLLING BACK THE PATTERN INTO POSITION FOR RAMMING ANOTHER MOLD

process and its application on a large scale were dependent chiefly upon the reduction of the time factor and upon making it a continuous process which could be operated without additional labor during the entire 24 hours. Through the courtesy of the Globe Machine & Stamping Co., illustrations of the latest and most improved type of this concern's sherardizing equipment are presented herewith, by which it has been able to reduce the time for the sherardizing treatment to six hours per heat, and at the same time improve the quality of the work, enabling manufacturers to run four heats per day without adding to the necessary day force of two men. The equipment units may be described as consisting of one oven and four sherardizing machines and two transfer cars with necessary tracks, forming a rectangle and having a short spur, not shown, extending at a right angle to the pit, seen at the right in Fig. 2. The sherardizing machine consists of three drums mounted on a car, as shown in Fig. 1. Each drum has a gear at one end, which meshes with the worms on the sprocket shaft. When the machine is in the oven the sprocket is outside and is revolved by power at the rate of about one revolution per minute, and therefore during the entire time the machine is in the oven the drums are in motion, thus bringing fresh zinc dust in intimate contact with the articles being treated and assuring the heating of the contents of the drums in less time than if the latter were stationary. This acceleration in the heating is due to the fact that as the zinc dust is a poor conductor the revolving action brings all the dust into contact with the drum surfaces in turn, instead of compelling the heat to reach the center of the mass by conduction. Fig. 2 shows two machines outside the oven; the sprocket of a third may be seen protruding from the oven door, while a fourth stands under the dust hood. The machine, having been run under the hood, is

FIG. 8—IMPROVED 24-INCH SQUEEZER

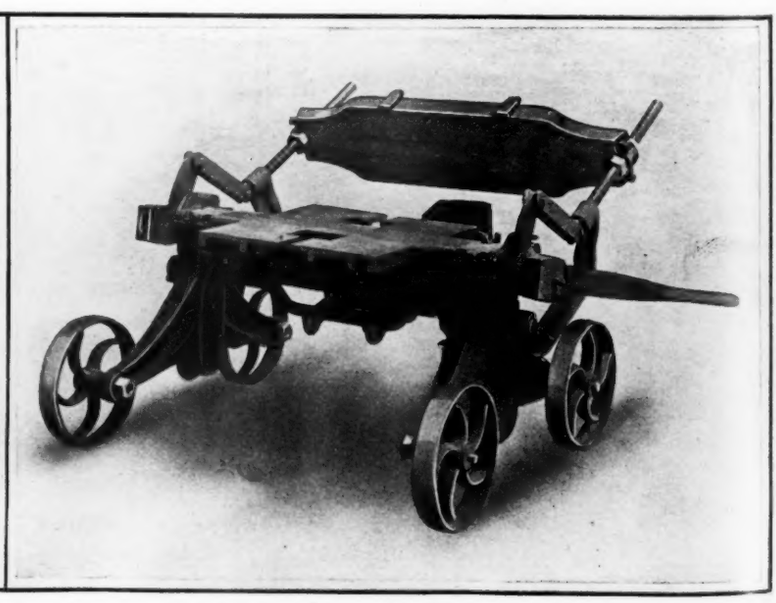

FIG. 9—PORTABLE HEAVY DUTY SQUEEZER

emptied by removing the tops of the drums and turning the latter through a partial revolution. The hood prevents the zinc dust from escaping into the shop and after the lapse of a few minutes, the treated articles are removed from the screen upon which they have been dumped, and through which the zinc dust falls to be subsequently used again with other charges.

The operation of the plant is as follows: Starting with four empty machines, two laborers load one with material to be treated, together with the necessary zinc dust and push it into the oven. The second machine is then loaded and pushed out on the spur track previously referred to. This occupies the greater part of one shift —say a forenoon. By noon the machine in the oven is ready to be drawn and it is run out to the left, Fig. 2, and allowed to cool, and the second machine, previously loaded, takes its place in the oven. The third machine is now loaded and run onto the spur track and the fourth is also loaded and left over the pit. This completes the day. The second machine, which was run into the oven at noon, is now ready to be drawn. The machine first taken out, therefore, is moved and the second one takes its place, the third machine being run into the oven. At midnight the watchman withdraws the third machine and runs the fourth into the oven. In the morning the two day men find two machines cool enough to empty and refill and the cycle is begun over again.

The drums of the sherardizing machine will hold about four kegs each of such material as bolts, washers, screws, etc., and three kegs of zinc dust, and the labor required is easily within the capacity of two men. Either gas or oil may be employed in the heating of the oven. The erection of the oven and tracks and the assembling of the machines and transfer cars can be accomplished by ordinary shop labor.

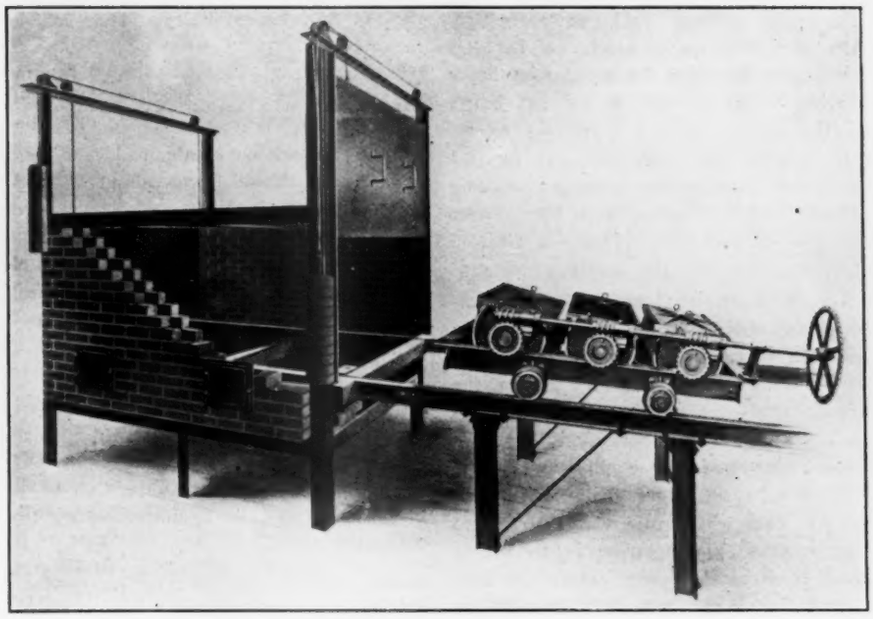

FIG. 1—THE SHERARDIZING MACHINE

MALLEABLE ANNEALING OVENS.

BY RICHARD MOLDENKE

Question:—What should be the composition of the gases in malleable annealing ovens to obtain the best results and to prevent the burning of the pots, castings, etc.? Are automatic stokers in connection with annealing ovens of any advantage over hand firing?

Answer:—Naturally, in order to prevent the burning away of metal, there should be as little free oxygen present as possible. The fuel used should have been given just enough air to burn it without the formation of smoke. If this is done, the gases will contain a maximum of nitrogen, and very little unconsumed oxygen.

Where coal firing is resorted to, it is well to have a large grate area, so that a slow fire may be maintained. Forcing the fire means the introduction of an excess of air to burn the coal quickly, and the result, after full heat has been reached, will always be unduly burnt pots. The castings in the pots should not suffer, no matter how the oven is fired, for the saggers should be luted up well after careful packing, so that no settlement takes place in them—provided the proper temperature has not been exceeded—and consequently no channels for upward air currents may form. The top covering of mud, as it is often called, consisting as it does of the dust from the hard-rolling room, should be applied thickly, or else, in important cases, a plate of steel or iron should be substituted for the mud.

Where the hard castings are made from metal that has not been oxidized unduly in the melting operation, there is not as much danger of wasting or being over-annealed as where this undesirable condition has been brought about. Metal that has been in the furnace too long is peculiarly sensitive to the annealing process, and even with proper temperatures will show signs of having apparently been over-heated or scaled. This condition is often blamed upon the annealing oven and the manner of heating it, whereas the trouble lies in the melting furnace.

The fact that it is difficult to regulate a coal fire on account of the necessary periodical cleaning and adding of fresh coal, and hence at times, more air has to be admitted than is desirable, unless heavy smoke is to result, has turned attention to the easier and better methods of gas firing. Where natural gas is available, it is unwise to use anything else. But in the absence of

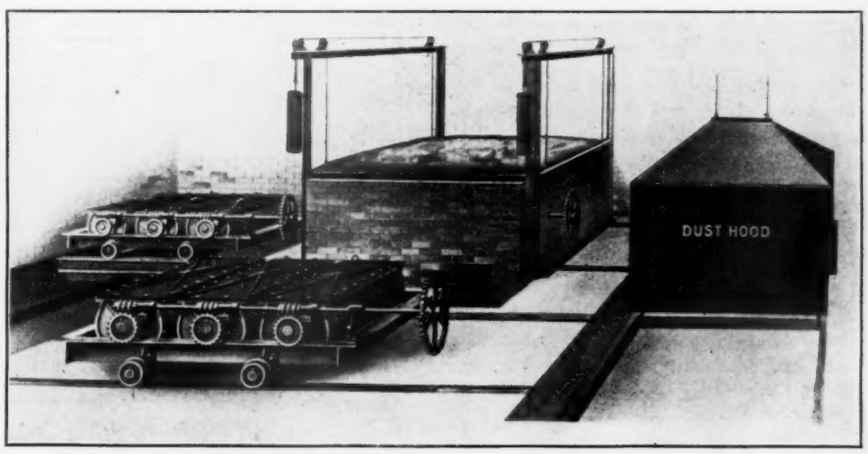

FIG. 2—GENERAL ARRANGEMENT OF SHERARDIZING EQUIPMENT

this rich natural fuel, producer gas fills the bill quite nicely. There is nothing better than the soft, quiet flame coming from the top of the gas boxes in the corner of the annealing ovens. Air is admitted below the gas in just sufficient quantity to prevent making smoke, and no more, and the slower the gas—in plentiful volume—is allowed to enter, the less the waste of iron.

Gas installations, however, are expensive, and should not be resorted to unless the producer gas made is desired for melting purposes also. Hence the proper way—gas not being available—is to burn the coal under conditions that make for uniform combustion. The best way, apart from firing with pulverized coal where one wants to go to that expense and trouble, is to use a good mechanical stoker. Here the fuel is fed in slowly and automatically, as the ash drops out, preferably into a water-sealed pit, and may be removed without disturbing the draft conditions.

Uniform and effective firing results, with a minimum of waste of the pots. Slack coal is preferable to lump coal, as the entrance of air can be better controlled at the grates, apart from the damper arrangement of the ovens themselves. This method is essentially ahead of hand-firing, particularly as for the larger installations the saving in fuel compares with that in boiler practice.

In the articles on malleable cast iron published serially in THE FOUNDRY, the results of the endurance of annealing boxes with natural gas under varying and high pressures, as compared with regulated gas at low pressures, strikingly indicated that the latter was the better condition. Less air was forced into the oven in proportion to the gas used; and that after all is the solution of the problem.

MIXTURES FOR STAMP SHOES AND DIES.

BY N. W. SHED

Question:—Can you give us a mixture for stamp shoes and dies? These castings are used for crushers in the mills of the mining companies in this vicinity.

Answer:—The shoes and dies used in stamp mills must resist shock as well as the wear of the hard rock material which is being crushed. The usual practice is to make the die softer than the shoe. The shoe for some kinds of rock may be of chilled metal like a car wheel, and the die may be a dense iron, unchilled. In some cases wrought iron has given as good service as a die.

A car wheel mixture for shoes and dies is quite satisfactory. This can be made of

	Per cent.
No. 2 pig iron	25
Car wheels	50
Scrap	25

This should have about 1 per cent silicon and should show about ½ inch chill when cast against cold iron.

A better mixture can be made of semi-steel. This should be low in phosphorus and silicon, sulphur fairly high, manganese 0.40 per cent to 0.60 per cent. This can be made of

	Per cent.
Low phosphorus pig, silicon 1.40 per cent	30
Car wheels or charcoal pig	25
Steel	20
Hard scrap	25

This should give a chill ½ inch to ¾ inch, and would have approximately this composition:

	Per cent.
Silicon	0.90
Sulphur	0.11
Phosphorus	0.30
Manganese	0.55

For many mills it would be a good practice to cast the shoe against a chill, and cast the die in sand. If the shock of striking tends to chip the shoe, it would be better to cast both shoe and die in sand.

The wear on cast iron is usually so great that many mills are using forged steel, or better, chrome steel for shoes and dies. These wear so much longer that the cost per ton of ore crushed is usually less than cast iron. This is shown in the following table:*

Name of district.	Metal.	Weight, pounds. New.	Weight, pounds. Worn.	Ore crushed, tons.	Metal worn per ton of ore crushed, ounces.
Gilpin Co., Colo.	Shoes, cast iron	83	27	80	11.2
	Dies, cast iron	48	26	78	4.5
	Shoes, chrome steel	111	31	202	6.3
	Dies, chrome steel	55	25	159	3.0
Grass Valley, Cal.	Shoes, chrome steel	152	48	251	6.6
	Dies, cast iron	93	45	96½	7.9
Angel's Camp, Cal.	Shoes, chrome steel	175	40	585	3.6
	Dies, cast iron	95	35	275	3.5
Mammoth, Ariz.	Shoes, chrome steel	132	40	190	7.7
	Dies, chrome steel	120	37	240	5.6
Australia.					
Bendigo, Victoria	Shoes, cast iron	180	38	115	19.7
	Dies, wrought iron	98	26	335	3.4
Clunes, Victoria	Shoes, cast iron	196	56	105	21.3
	Dies, wrought iron	138	30	420	4.1
Harrietville, Victoria	Shoes, fagot iron	172	38	195	11.5
	Dies, fagot iron	84	37	200	3.7

A comparison of the wear upon chrome steel, forged steel and cast iron, is shown by the table of Wood and Doveton:†

	Weight, pounds. New.	Weight, pounds. Worn.	Wear per ton crushed, pounds.
SHOES.			
Chrome steel	140	35	0.318
Forged steel	137	40	0.43
Cast iron	135	40	0.75
DIES.			
Chrome steel	76	22	0.42
Forged steel	143	50	0.36
Cast iron	140	50	0.75

*T. A. Rickard, Am. Inst. Mining Eng., Vol. 23, p. 562.

†Am. Inst. Mining Engineers, Vol. 33, p. 531.

TRADE NOTES.

The Ross-Tacony Crucible Co., Tacony, Philadelphia, Pa., manufacturer of black lead crucibles, stopper heads, lubricating plumbago, etc., announces that William C. Yenger has been placed in charge of its New York office, 1171 Fifth Avenue building. Mr. Yenger, as eastern representative of this concern, will call on the trade throughout New York state, northern New Jersey, and the New England States.

Benjamin K. Hough has been appointed Boston sales manager of the Wisconsin Engine Co., Corliss, Wis., with offices in the Oliver building. Mr. Hough will represent this concern in the New England States.

The Pittsburg office of M. A. Hanna & Co., Cleveland, has been removed to suite 1844, Henry W. Oliver building, Pittsburg.

The Enterprise Sand Co., Pittsburg, miner and shipper of molding sands, has sent to the trade a handsome folder, soliciting inquiries for the shipment of sand during the present season.

The Jonathan Bartley Crucible Co., Trenton, N. J., has opened an office in Philadelphia in the Bourse, in charge of L. T. Ward.

Edward Brown & Son, 311 Walnut street, Philadelphia, manufacturers of the Brown pyrometers and other recording instruments, announce a change in their firm name to the Brown Instrument Co. An office has also been established in the Oliver building, Pittsburg, in charge of W. H. Gibb.

Smith, Emery & Co., Inc., 651 Howard street, San Francisco, are sending to the trade an iron and steel inspection catalog, which describes the class of work this firm of chemical and inspecting engineers is prepared to undertake.

The Northern Engineering Works, Detroit, is now installing many new tools, consisting of lathes, gear cutters, milling machines, etc., contracts for which were placed several months ago.

This concern reports a large volume of business on its books and the demand for electric traveling cranes is unusually heavy.

The Adams Co., Dubuque, Ia., has issued a circular containing a reprint of the article published in the March issue of THE FOUNDRY, describing the use of hinged match-plates in the plant of the Michigan Stove Co., Detroit. In addition, the Farwell squeezer, made by this concern, is shown as operated with match-plates.

The Moyer tramrail department of the J. W. Paxson Co., Philadelphia, has closed contracts for equipping the plants of the United States Heater Co., Detroit, and the Kennedy Valve Mfg. Co., Elmira, N. Y., with the Moyer overhead tramrail system.

The Ohio Welding & Mfg. Co., 828-830 West Sixth street, Cincinnati, has installed a large oxy-acetylene demonstrating plant, including not only the welding equipment but also an oxygen plant, and will represent the Davis-Bournonville Co., 90 West street, New York City, in Ohio. A demonstrating and repair shop will also be established at Cleveland, 2121 East Second street, in the near future. These shops will engage in the repair of broken or cracked iron, steel, malleable and non-ferrous metal castings by the oxy-acetylene welding process.

The Providence, R. I., warehouse of the J. W. Paxson Co., Philadelphia, has been established at 36 Exchange Place. A complete line of foundry supplies for the New England trade will be carried in stock. William T. Nicholson is in charge of this branch.

The Anthony Co., 45 West Thirty-fourth street, New York City, has taken over, as licensee, the manufacture and sale of the oil burners and oil-burning equipment of the American Combustion Co., of that city. Officers have been elected as follows: Nicholas W. Anthony, president; A. Rowan Anthony, vice president; Harry J. Lucas, secretary-treasurer; Charles Boone, general manager.

The Hauck Mfg. Co., 140 Cedar street, New York City, is sending to the trade a 4-page folder, illustrating and describing its kerosene torch, which can be operated with kerosene as fuel in place of gasoline. The torch is so constructed that the tank will remain cool while the burner is being operated. A circular is also being sent to the foundry trade by this concern, describing Hauck fuel oil burners, which are adapted for lighting cupolas, burning-on castings, skin drying and baking molds and cores. It is stated that these burners are in use in more than 2,100 foundries in the United States and foreign countries.

The Hoskins Mfg. Co., Detroit, has equipped a very interesting exhibition room in connection with its office, at 321 Dearborn street, Chicago. Electric furnaces, in crucible, muffle and special tube chambers, of three distinct types, are demonstrated for various industrial laboratory operations, and the heat treatment of all kinds of steel. A further feature of the display is a complete installation of electric pyrometers, so connected as to register on a meter at the central switchboard, by means of a selective switch, the temperature of any particular furnace. The great advantage of using this high temperature measuring device in connection with the operation of furnaces for steel treatment, is clearly shown.

TRADE PUBLICATIONS.

COMPOSITION MATCH-PLATES. — The Bayer Pattern Plate & Mfg. Co., Poe avenue and W. Twenty-fifth street, Cleveland, has issued a 12-page, illustrated catalog, describing its composition match-plates. This concern is prepared to make match-plates from any pattern, regardless of size.

FORGE BLOWERS.—The B. F. Sturtevant Co., Hyde Park, Mass., in a four-page pamphlet, describes an electric forge blower, which consists of a pressure fan of the mulivane type, inclosed in a steel plate casing, driven by a direct-connected motor built to operate from electric lighting circuits. The particular features of this blower set are compactness and high efficiency, due largely to the multivane type of wheel.

SNAP FLASKS.—Baldwin, Tuthill & Bolton, Grand Rapids, Mich., have issued a 36-page catalog describing their line of all-steel, tapered snap flasks for bench and machine molding. The bench flask outfits, regularly furnished, comprise cope, drag and six jackets. In addition, pattern and crating room machinery is shown, including automatic filers, saw sharpeners, bench grinders, tilting top saw tables, planers, band saws, etc.

WOOD-WORKING MACHINERY. — The Crescent Machine Co., Leetonia, O., has issued a 96-page catalog which illustrates and describes its extensive line of wood-working machinery. This includes band saws of various types, saw tables, shapers, jointers, planers, etc. An extensive line of tools, motor-driven, is also illustrated. All of this equipment is adapted for pattern shop use. The catalog is handsomely illustrated and the tools are described in detail.

AIR TOOLS.—The Cleveland Pneumatic Tool Co., Cleveland, has issued an illustrated 36-page catalog, describing its extensive line of pneumatic tools, including riveting, chipping, beading, calking and scaling hammers, drills, wood boring machines, grinders, etc. The chipping hammers are especially designed for foundry use for cleaning castings, while the portable line of grinders can also be used to advantage in cleaning departments of casting shops. In addition, an oscillating valve grinder is also shown. The extensive line of drills made by this concern is illustrated on an insert bound in the center of the catalog.

SELF LUBRICATING BEARING METAL. —The New Era Mfg. Co., Kalamazoo, Mich., in a 20-page booklet describes self-lubricating bearing metal, which consists of a high grade anti-friction alloy reduced to a sponge-like form, in which the metal portions are highly attenuated, and treated with lubricating oils, thus converting the entire mixture into a mass of metallic lubricants. For use as a bearing material it is compressed into the desired form, and such bearings require no lubrication except that contained within the bearing material. This concern also manufactures metallic phosphoro, aluminized nickel, aluminized zinc, ferro-zinc, die casting alloys, white brass, babbitt metals, solders, etc.

BASE HEATER.—The American Blower Co., Detroit, in bulletin No. 273, describes a sectional base heater for use in connection with fans and blowers for heating, ventilating and drying. It consists of a heavy cast iron base with four rows of holes tapped into the top. Into these openings are screwed 1-inch steam pipes. The upper ends of each alternate row are joined together by elbows, with short horizontal nipples between. The aggregate heating surface is made up by adding a number of these sections to one group. The standard apparatus is usually encased in a sheet steel jacket, although these heaters are frequently encased with brick or hollow tile walls. A capacity table is also included in this bulletin.

TROLLEYS AND CHAIN BLOCKS.—Bulletin No. 17, superseding No. 14, issued by the Pawling & Harnischfeger Co., Milwaukee, describes its I-beam trolleys and chain block traveling cranes. The I-beam trolleys are designed to travel on the lower flanges of single or double I-beams of various sections for each size of trolley, and are of value wherever material of moderate weight is to be moved. The trolley frames are of steel, cast in one piece, designed for the greatest possible strength. The wheels are large in diameter with spherical tread, the axles are steel and are fitted with improved roller bearings, making a very free and easy traveling trolley. The various parts of the trolley are illustrated in detail, attention being directed to the special features. The bulletin contains 12 pages, and in addition to the trolley, describes the dispatch hand hoist which is especially designed for rapidly lowering a load. Various examples of overhead track installation are illustrated and described, and the adaptability of the chain block and I-beam trolley for use on wall cranes is shown.

CINDER CRUSHERS.—The Eastern Machinery Co., New Haven, Conn., in a 12-page catalog, illustrates and describes the improved Hill cinder crushers, especially adapted for pulverizing and cleaning brass foundry cinders, skimmings, etc. This cinder crusher was invented and patented by R. M. Hill, a practical foundryman, who manufactured them until his retirement from business quite recently. The machines are simple, very substantial and easily operated. The barrel is positively driven by gears, and the crushing roll has specially shaped pockets for stirring the material being crushed. The illustrations show the machines arranged for either the wet or dry process. In the wet process the heavy crushing roll inside crushes the ashes, separating the metal, which drops to the bottom, while the dirt and cinders are floated out by the force of the water passing through the barrel. The dry process is faster than the wet, but does not give as clean metal. The material is crushed the same, but the ashes and dirt are removed by the suction of an exhaust fan into a receiving chamber, which is furnished with air tight doors, for the removal of the accumulating refuse.

GENERAL INDUSTRIAL NOTES

Fred W. Abele, Chicago, has purchased the shop of the Eagle Aluminum Co., Minocqua, Wis., and will reopen the plant.

The Wilmot Engineering Co., Hazelton, Pa., has leased a foundry at that place formerly operated by the Harleigh Iron Works.

The Deemer Steel Castings Co., Newcastle, Del., will install another converter and is adding other equipment to its steel casting plant.

The works of the Reliance Steel Foundry Co., Delawanna, N. J., have been sold to the Wilmington Steel Works, Wilmington, Del.

The Keystone Steel Foundry Co., Avonmore, Pa., manufacturer of gray iron castings, is preparing to begin operations in its steel casting department.

The Krupp Foundry Co., Ltd., Lansdale, Pa., manufacturer of cast iron pipe, fittings and general plumbers' supplies, has been incorporated with $100,000 capital, the firm name having been changed to the Krupp Foundry Co.

H. A. May has purchased the foundry formerly operated by Theodore B. Rohrman at Thirtieth and Ludlow streets, Philadelphia, and is operating it under the name of the Empire Foundry Co.

The Atlas Foundry Co., Detroit, has been organized with $50,000 capital by William Christian, Robert Crawford and John D. McKay. This concern has taken over the plant of the National Motor Casting Co.

The Dickson Malleable Iron Co. has been organized at Milwaukee with $150,000 capital by E. N. Dickson, formerly vice president and manager of the Milwaukee Coke & Gas Co. With him are associated Hugo A. Gutekunst and Willett W. Spooner.

New Construction.

S. J. Gardner, New Albany, Ind., is erecting a new foundry, 33 x 121 feet.

George Cutter & Co., South Bend, Ind., contemplate the erection of a foundry.

The Harrison Machine Works, Belleville, Ill., are erecting an addition to their foundry, 25 x 75 feet.

The Kalamazoo Stove Co., Kalamazoo, Mich., will erect an addition to its foundry, 100 x 140 feet.

The Imperial Mfg. Co., Minneapolis, will erect a foundry, 30 x 50 feet, and a machine shop, 80 x 200 feet.

The Buckeye Steel Casting Co., Columbus, is having plans prepared for an additional building, 150 x 300 feet.

The Wayne Works, Richmond, Ind., manufacturer of agricultural implements, will erect a foundry, 58 x 136 feet.

Levering Bros., Baltimore, will erect a new foundry at Monroe and Wicomico streets for the manufacture of sash weights and light castings.

The T. B. Woods Sons Co., Chambersburg, Pa., will erect a foundry and machine shop, 100 x 500 feet, as well as a pattern shop, 40 x 130 feet.

The Wehr Steel Co., 3018 Grand avenue, Milwaukee, contemplates the erection of a crucible steel casting foundry, but thus far no site has been selected.

The Weller Mfg. Co., Chicago, will erect a new plant consisting of a foundry, 100 x 200 feet; machine shop, 250 x 300 feet, and office building, 50 x 250 feet, three stories high.

The National Steel Casting Co., Montpelier, Ind., is building a large addition to its foundry, 56 x 140 feet. With this extension the entire length of the shop will be 580 feet.

The Lima Locomotive & Machine Co., Lima, O., will enlarge its plant by the erection of a foundry, 130 x 180 feet. Plans are being prepared by the Osborn Engineering Co., Cleveland.

The Anniston Foundry & Machine Co., Anniston, Ala., will erect an addition to its foundry, 320 x 120 feet. Other extensions include a machine shop, storage room and pattern shop.

The Hayes Pump & Planter Co., Galena, Ill., is having plans prepared by Raeder & Wood, Great Northern building, Chicago, for the erection of additional buildings, which include a gray iron foundry.

Heauford Bros. & Hitchens, Waterloo, Ia., will extend their plant by the erection of another building, 100 x 400 feet, and the melting equipment will be doubled by the installation of another cupola.

The Tuttle Motor Co., Canastota, N. Y., recently incorporated, will erect a foundry and machine shop. The main building will be 40 x 180 feet, with an ell, 40 x 86 feet. This concern will manufacture automobile, marine and stationary gasoline engines.

The Farrell Casting Co., Sandusky, O., will enlarge its plant by the erection of a foundry, 100 feet square. A five-ton traveling crane, cupola, blowers, motors and other equipment will be required, orders for which will be placed by the Osborn Engineering Co., Cleveland.

The General Electric Co., Schenectady, N. Y., will make further additions to its plant at Pittsfield, Mass., which will include a pattern storage building, 80 x 160 feet; annealing house, 80 x 120 feet; storage and assembling shop, 80 x 600 feet, and machine shop, 120 x 375 feet.

The Westinghouse Electric & Mfg. Co., Pittsburg, is contemplating the erection of a large gray iron plant at Trafford City, Pa., and it is probable that a steel department will also be included in the new shop. The Westinghouse Electric & Mfg. Co. now operates foundries at Allegheny, Pa., and Cleveland.

The Lancaster Foundry Co., Lancaster, Pa., incorporated with $30,000 capital, is erecting a malleable and gray iron foundry, the main building of which will be 55 x 300 feet. The officers of the company are Aaron B. Hess, president; James R. Haldeman, vice president and general manager; William V. Wissner, secretary and treasurer.

The Jacob J. Vollrath Co., Sheboygan, Wis., is erecting an enameled ware plant, consisting of the following buildings: Warehouse, 220 x 378 feet; enameling room, 150 x 252 feet; mill building, 80 x 115 feet, and pickling room, 82 x 110 feet. This concern already operates a large foundry for the manufacture of cast iron sanitary ware.

The business of the Milford Foundry, New Milford, Conn., whose plant was recently destroyed by fire, has been incorporated with $25,000 capital, under the name of the New Milford Foundry & Machine Co. J. A. Northrop is president and superintendent, and Harry G. Northrop is treasurer and secretary. Work on the new buildings is already under way. The plant will include a machine shop 40 feet square, two stories high, and a foundry, 34 x 60 feet.

Among the Brass Foundries.

T. Schueler & Co., Newark, N. J., will erect a brass foundry, 25 x 50 feet.

The Ferd. Messmer Mfg. Co., St. Louis, will build a 30 x 150-foot addition to its brass foundry.

T. F. McGann & Sons Co., 104 Portland street, Boston, will erect a brass foundry, 50 x 150 feet.

The G. Oberdorfer Co., Syracuse, N. Y., manufacturer of brass and aluminum castings, will erect an addition to its foundry, 60 x 100 feet.

The Thiery & Kendrick Mfg. Co., 660 Franklin street, Detroit, has completed a large brass foundry, the main building of which is 102 x 200 feet.

The M. Blassberg Brass Foundry, Turners Falls, Mass., has recently installed five crucible furnaces for melting brass, bronze and aluminum.

The National Fulton Brass Mfg. Co., Detroit, manufacturer of car brasses, will erect a new plant in that city at a cost of approximately $100,000.

The Hewitt Mfg. Co. will erect a new foundry in St. Louis, 200 feet long. The A. E. Baxter Engineering & Appraisal Co., Buffalo, is preparing the plans.

The Cramer & Kiely Brass Foundry Co. has established a plant for the manufacture of brass, bronze and aluminum castings, on Burnett near Teall avenue, Syracuse, N. Y.

The David Bradley Mfg. Co., Bradley, Ill., has purchased the plant of the Hartford Plow Co., Hartford, Wis., and will add a brass and aluminum foundry, as well as a drop forge plant.

The Hudson Brass Works, 2 Howard street, New York City, recently incorporated, will manufacture brass fittings for the chandelier and plumbing trades, as well as brass automobile goods.

The United States Aluminum Co., a subsidiary of the Aluminum Co. of America is operating, under lease, the plant of the Lackawanna Foundries, at Dover, N. J., manufacturing aluminum-bronze powder.

The Ohio Metal Co., 502-506 W. Kimball street, Columbus, smelter, refiner and dealer in metals and metal drosses, has purchased the entire plant of the New Process Metal Co., of that city, together with its babbitt metal formulas.

The Fairbanks-Morse Mfg. Co., Chicago, contemplates the erection of a new brass foundry at Beloit, Wis., which will have a capacity of 44,000 pounds of castings daily. This concern would like to receive catalogs from manufacturers of brass foundry equipment.

The Reed & Prince Mfg. Co., Worcester, Mass., has established a department for the manufacture of small brass and bronze castings and has also installed equipment for machining and polishing. Plans are being made for the manufacture of a line of hardware specialties.